JOURNAL
OF THE
AMERICAN WATER WORKS ASSOCIATION

Vol. 35 MARCH 1943 No. 3

Contents

All correspondence relating to the publication of papers should be addressed to

Harry E. Jordan, Secretary
500 Fifth Avenue, New York

$7.00 of Members dues are applied as subscription to the Journal
Additional single copies to members—50 cents
Single copies to non-members—75 cents

JOURNAL
OF THE
AMERICAN WATER WORKS ASSOCIATION

Vol. 35 | March 1943 | No. 3

Computation of Flows in Distribution Systems

By Weston Gavett

THE introduction of the Hardy Cross method for computing the flows in distribution systems has revived interest in this most important phase of water works engineering. The well deserved acclaim accorded this excellent method has given some writers, including editors, the misconception that, before the Hardy Cross method, it was not possible to design a distribution system and that pipe sizes were determined entirely by guesswork. Some of the older methods are discussed in this paper, together with another graphical method and chart for use in pipe studies.

Various formulas are used in the computation of the hydraulics of pipe systems. The formula is important, as it affects somewhat the ease of calculation in arithmetical methods and should correspond with the characteristics of models, such as the electric analyzer of Camp and Hazen (1) or the hydraulic analyzer described in this paper. A preliminary test of this hydraulic network analyzer using orifices is also reported here.

Older Methods of Network Flow Analysis

In a recent paper on the Hardy Cross method, the following statement was made:

"Prior to the inception of this method it was impossible to design, with any degree of accuracy, facilities for an increase of supply to any particular point in a grid system. Good judgment based on experience was the only basis of procedure."

The originators and proponents of the Hardy Cross method have never, to the writer's knowledge, made this claim. On the contrary, it was presented as a method that would give accurate results faster and easier than older methods. Its acceptance as a preferred method is attested by numerous papers by writers who have used

A contribution by Weston Gavett, Assoc. Engr. with Clyde Potts, Cons. Engr., New York.

it successfully. The discussion of older procedures is considered important, not only for historical accuracy, but also to call attention to alternate tools for doing the same work. Pipe-flow studies are made for various purposes and the same method may not be best for all applications.

For a very comprehensive discussion of the "Hydraulic Investigation of Water Distribution Systems in Field and Office," the reader is referred to a paper of that title by Fair (2). This paper includes the basic data governing design of distribution systems, covering such factors as pressures, fire flows, hydrant tests, etc., as well as giving a description of the application of the Hardy Cross method and its derivation. Other methods described include the "method of sections" and the "method of equivalent pipes." Also mentioned are Freeman's graphical method as expanded by Howland (3) and Camp and Hazen's hydraulic analysis of distribution systems by an electric analyzer.

Freeman Method

To illustrate the antiquity of the knowledge of network analysis, one may refer to the description of a graphical method of network analysis by Freeman, dated June 8, 1892 (4). In this paper, the author showed the application of his method, not only to compound pipe in series and parallel, but also to a fairly complicated net.

In 1916, Kingsbury (5) described the use of the graphical method in solving a composite twin pipeline problem.

Palsgrove (6), in 1931, illustrated the application of graphical analysis to a dual-flow water supply system and in 1932 used a formula derived from Reynolds' work and applied it to the solution of special problems in pipe flow by graphical analysis.

In 1934, Howland (3) described the use of the Freeman method for determining flows in grid systems and in 1937 a very complete discussion of the application of Freeman's method to complicated networks, with examples of solution, was given by Aldrich (7).

It is generally conceded that the Hardy Cross method is faster and preferable to the Freeman and other methods for the analysis of flows in networks. There are special problems, however, where the Freeman or other graphical methods could be used to advantage. For example, Novoro (8) has recently demonstrated the advantages of the graphical method in solving a multiple reservoir problem described and analyzed by the Hardy Cross method by Muir (9). Novoro points out that: "to determine graphically all the individual discharges for a given total flow involves a little more work than with Muir's solution [Hardy Cross method], but, once the required charts are prepared, it is possible to study the effects of several different total discharges with very little effort."

Method of Sections

Fair (2) states that this method, an approximate one, was employed by Hazen as a quick check of distribution systems, and outlines its application.

Slide Rule Method

The slide rule method is quite similar to the method of equivalent pipes described by Fair (2). The writer has used it for about twenty years and believes it has been generally used by engineers of the National Board of Fire Underwriters and others for many years. A well worn book found in

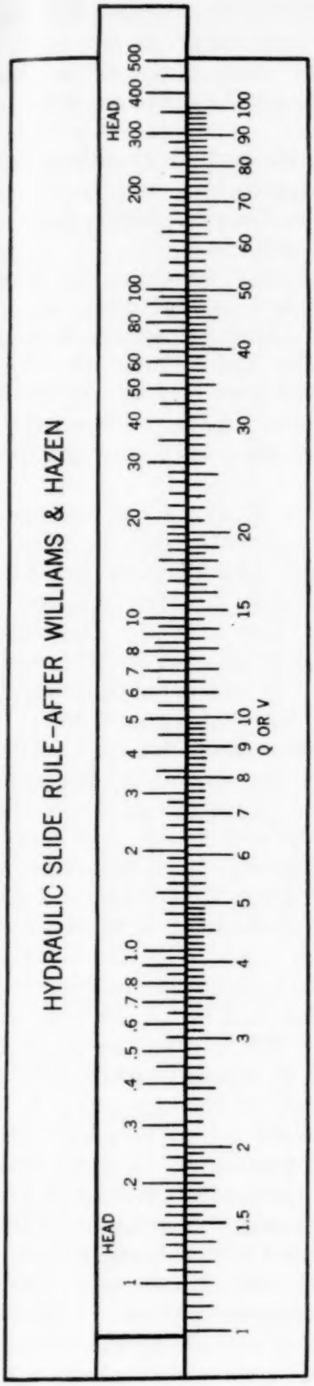

Fig. 1

every hydraulic engineer's office is *Hydraulic Tables,* by Williams and Hazen (10), published in 1905. As the figures in these tables were prepared from a hydraulic slide rule, the rule is older than the tables. It is reasonable, then, to suppose that the slide rule was used at an early date for solving network problems. The use of the slide rule has been mentioned, but to the writer's knowledge, little has been written on its application to the solution of grid problems.

A pipe-flow diagram with the head-flow relationship plotted for various pipe sizes may be used in lieu of the slide rule. The rule is useful if only to interpolate values from the Williams-Hazen tables and is convenient in solving many pipe-flow problems. Such slide rules were sold at one time, but may be readily constructed for the Williams-Hazen or any exponential formula. If the Darcy, simplified Mills or V^2 type formula is used, a common slide rule will serve, using the base 10 scale for flow and the base 5 scale for head, if a 10-in. rule is used.

Figure 1 shows a slide rule prepared for the Williams-Hazen formula. The commercial rules have additional scales for pipe sizes and C and so are self-sufficient. The writer uses the rule in connection with the book of hydraulic tables (10). The rule is used for the head-flow relationship only. Such a rule may be constructed by plotting the formula on logarithmic cross-section paper and using the projections of this line on the X and Y axes for the scales. These scales may then be pasted on an inexpensive slide rule of the type obtainable at any five-and-ten-cent store.

For the Williams-Hazen formula ($v = cr^{0.63}s^{0.54}0.001^{-0.04}$), a 5-in. base for the flow or velocity scale would require a 2.7-in. base for the head scale

($5 \times 0.54 = 2.70$). If desired, settings may be made on the upper scale for pipe sizes.

In using the slide rule, each pipeline is represented by two figures—Q/H or flow/head. Where possible, compound pipes are reduced to an equivalent Q/H relationship. This is similar to the equivalent pipe method, except that a Q/H value is used to represent the system rather than a length of a certain size pipe equivalent in capacity to the system.

This is done in the usual manner, as illustrated by the following simple examples:

A. 2000 ft., 10-in. pipe, $C = 80$, followed by
B. 1000 ft., 6-in. pipe, $C = 100$.

a. *Compound Series Pipe:*

Pipe	Q *mgd.*	*Loss of Head—* Hf *ft./1000*	*Total*
A. 2000 ft., 10-in., $C = 80$	1.00	7.7	15.4
B. 1000 ft., 6-in., $C = 100$	1.00	61.0	61.0
Total lines A and B	1.00		76.4 ft.

$Q/H = 1/76.4$

b. *Compound Parallel Pipes—Loop*

Pipe	Q/H	*At Head* =	*Q from Slide Rule*
A. 2000 ft., 10-in., $C = 80$	1/15.4	50	1.9
B. 1000 ft., 6-in., $C = 100$	1/61.0	50	0.9
Both Lines		50	2.8

Q/H for Loop = 2.8/50

For the solution of a network, the following general procedure is used:

1. Q/H for each length computed.
2. Compound lines with no takeoffs are reduced to a single Q/H relationship.
3. Two or more Q/H values are assumed and noted on the plan. Enveloping values are used so that the true value will be between the assumed values.
4. Additional Q/H values are applied approaching the correct value until the flows and heads check to the desired accuracy.

In a large system, main lines are studied first, and secondary pipes neglected. After an answer is obtained with the main lines, the effect of secondary lines may be considered and refinements made. Experience will discover many short cuts that may be used.

Figure 2 shows the analysis of a simple network by the slide rule method. This network was used by Fair (2) to illustrate the use of the Hardy Cross method. The Williams-Hazen formula with $C = 100$ was used.

The first step is the determination of the Q/H value for each line. These are indicated on the plan. The first assumption shown is designated *a*. Starting at corner *A*, where there is an intake of 2.00 mgd., 0.8 mgd. is assumed in pipe 1. The flow in pipe 3 is necessarily $2.00 - 0.80 = 1.20$. At corner *B*, 0.6 mgd. is taken off, so the flow in pipe 2 is $0.8 - 0.6 = 0.2$. From the slide rule, the friction losses for pipes 1, 2 and 3 are obtained and noted. The friction loss to corner *C* is 21.3 ft. through pipe 3 and 3.57 ft. to corner *D* through pipes 1 and 2. This would require a backward flow in pipe 4 from *D* to *C*, which indicates that a greater flow should be assumed through pipe 1. A flow of 1.20 mgd. is assumed in trial *b*, and the procedure used in trial *a* is followed. This gives a loss through pipe 4 of 1.70 ft. from corners *C* to *D*, which seems more probable; so computations are con-

tinued. The loss of 1.70 ft. through pipe 4 gives a flow of 0.21 mgd. This establishes the flows through the remainder of the network as follows:

Pipe 6: $0.8 - 0.21 = 0.59$

Pipe 7: $0.59 - 0.2 = 0.39$

Pipe 5: $(0.6 + 0.21) - 0.6 = 0.21$

The corresponding losses are obtained from the slide rule. The total loss through pipe 5 is 15.2 ft. and through pipe 7 is 54.8 ft. Obviously the correct flow will be between trials

head, through pipe 7, of 26.5 ft. and through pipe 5, of 24.5 ft. This is considered sufficiently close for practical purposes. A further trial *e* comes as close as practical with the slide rule, the loss to *E* through pipe 7 being 24.9 ft. and to *E* through pipe 5, 25.3 ft.

In 1932 a comprehensive survey and report on the water system of the Village of Freeport, N.Y., was made by Clyde Potts and Baldwin & Cornelius. A study of the distribution system was

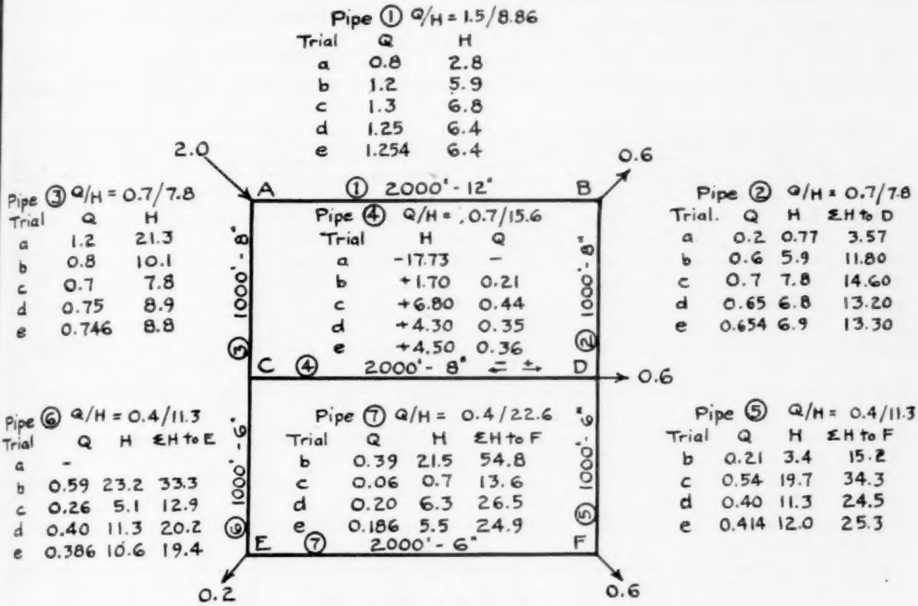

FIG. 2. Analysis of Simple Network by Slide Rule Method

a and *b*; the total loss to *F* will be between 15.2 and 54.8 ft.; and in the next trial the flow through pipe 1 should be increased. As trial *b* appears much closer to the correct value than trial *a*, the flow in pipe 1 for trial *c* is taken at 1.3. This leads to a total loss to *F* of 13.6 through pipe 7 and 34.3 through pipe 5, indicating that the flow of 1.3 through pipe 1 is too high and the correct value is between 1.3 and 1.2. A value of 1.25 is tried, giving a total

made in Potts' office, with recommendations for a comprehensive plan for strengthening mains to improve the system in the future. The slide rule method was used for this study and the computations made by S. R. Weibel. Without information on the character of the mains, a value of $C = 100$ was used for the computations. At the same time, hydrant tests were made at numerous locations in the village by Herbert M. Wood of Baldwin & Cor-

nelius. At several coincident points the computed discharges and actual discharges from hydrant tests were converted to the same loss of head and were found to be in remarkably close agreement. In some instances on the larger mains, the computed discharges were much higher than the actual. Investigation proved that the hydrants at these points were not directly connected to the large pipe, but through secondary parallel lines. An inspection of several sections of pipe cut out of the system also showed that the assumption of $C = 100$ was an appropriate one. The close agreement between computed and observed discharges was, of course, due to chance in the selection of the coefficient, but illustrates, nevertheless, that, with an appropriate coefficient, computations may be made with sufficient accuracy for all practical purposes.

The Circle Method

The circle method is an old method described in several text books. It is useful in determining the flows in a grid feeding a hydrant. Tyler (11) gives a good example of its application to the losses with hydrant flow in a regular grid system and compares its accuracy to results computed by the Hardy Cross system.

Equivalent Pipe Method

Another old method is that of equivalent pipes. This is described in some textbooks and in a paper by Howland and Farr (12).

The Hydraulic Grade Method

The writer has used a graphical method that is in effect a modification of the Freeman graphical method. It is a trial and error procedure and is not easy for a complicated network. It is useful for some problems such as indicating flows in loops and branch pipes and flows from reservoirs of different elevations. Graphical methods have an advantage in that, once the groundwork is done, flows in existing systems, if they are not too complicated, may be readily obtained. Such methods are also useful in that flow

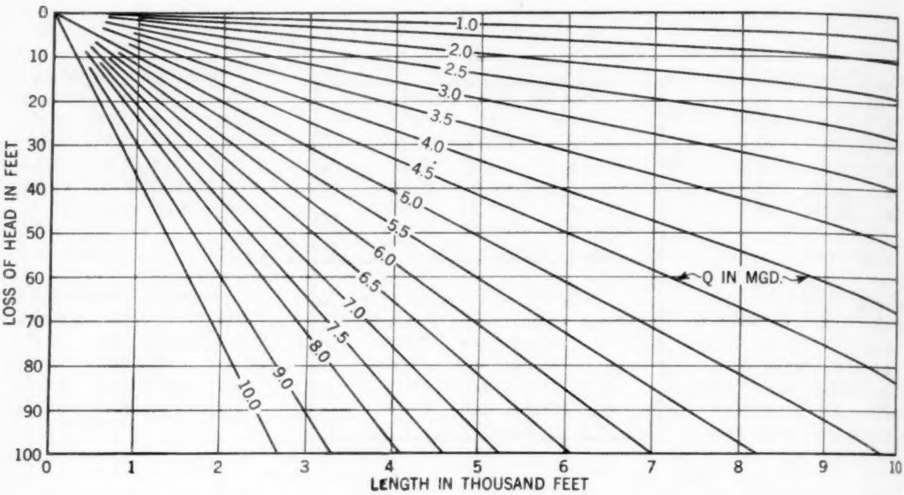

FIG. 3. Plotting of Hydraulic Grades for 16-Inch Pipe, $C = 100$

conditions in the system are visualized, so that lines which are too small become apparent at once.

The hydraulic grade method actually involves the plotting of the hydraulic grades in a system for given flow conditions. At first, sheets were prepared for each size of pipe, as shown on Fig. 3 for 16-in. pipe. By this method, for any length of pipe shown on the abscissa, the grade line for any flow is indicated.

These sheets were later replaced by a circular slide rule shown in Fig. 4. The original is $13\frac{1}{4}$ in. od. It consists of three parts. First there is a bottom card with length of pipe in thousand feet indicated on the outer circle. The other graduations are on the top card, which rotates. Above this is a celluloid strip on which loss of head from 0 to 100 ft. is indicated. The heads are plotted to scale of 1 in. = 20 ft. In operation, the size of pipe and Wil-

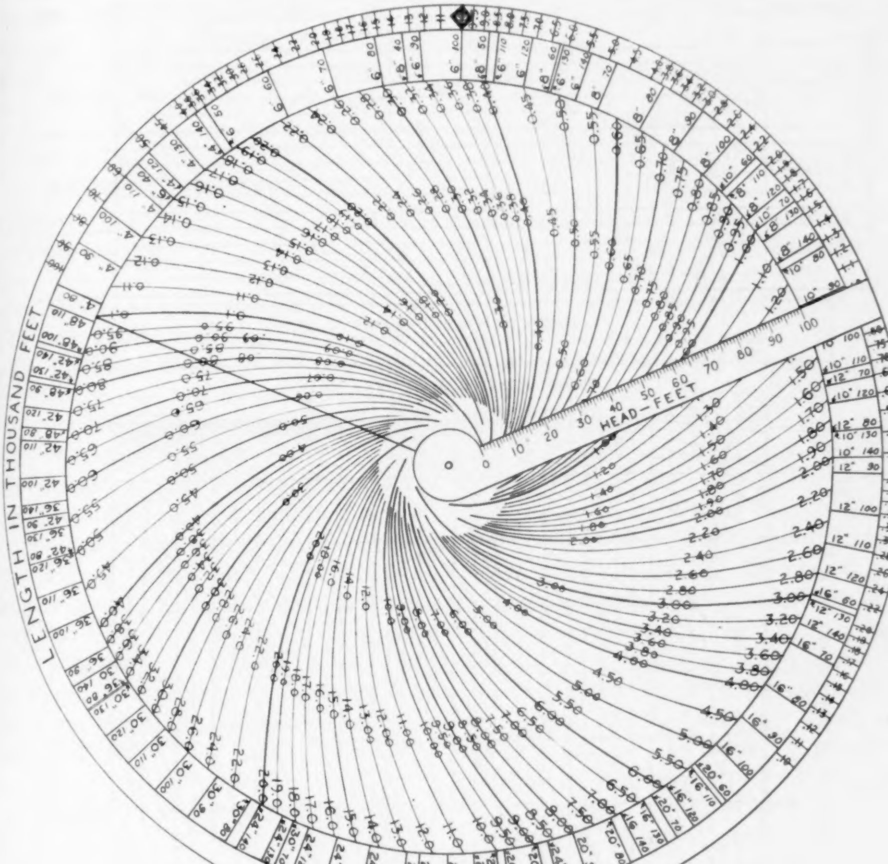

FIG. 4. Circular Slide Rule for Flow Determinations

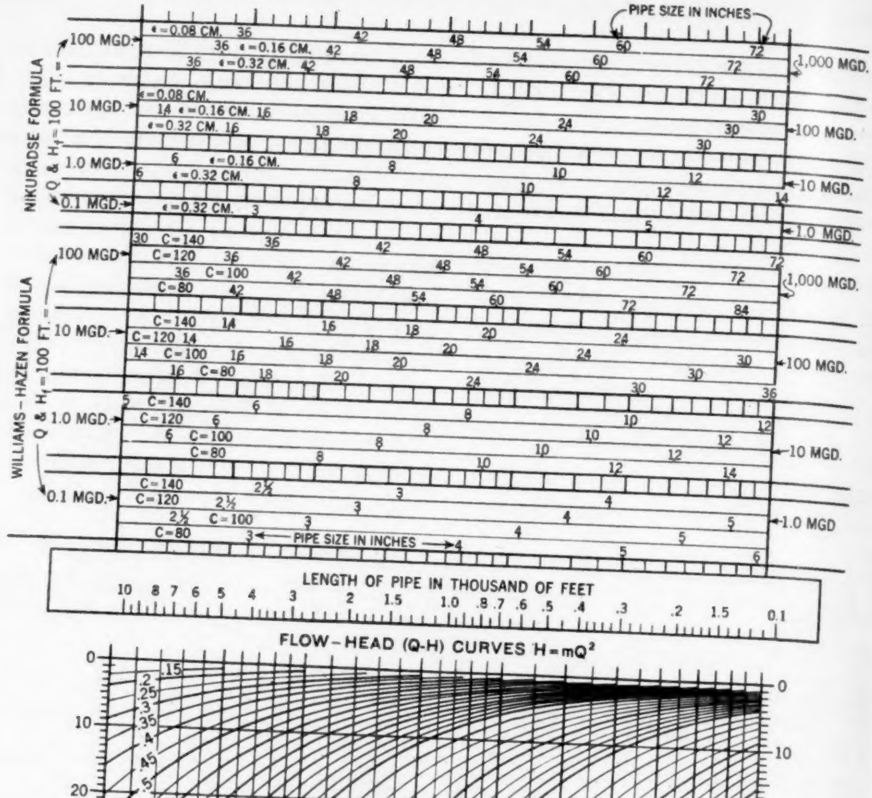

FIG. 5. Rectangular Chart for Flow Determinations (Pipe sizes shown in upper portion locate Q–H lines for sizes indicated that correspond to Q–H by the designated formula and coefficient at velocity of 3 fps., with Q in mgd. and H in ft./1000 ft.)

liams-Hazen coefficient C are set at the arrow at 10 thousand feet. In Fig. 4, the rule is set for 6-in. pipe where $C = 100$. The celluloid head slide is then set at the length of pipe, shown in the illustration at approximately 1000 ft. The loss of head for any flow is read at the intersection of the flow-line with the edge of the loss-of-head slide. In plotting hydraulic grades, a strip of paper is placed over the head slide and the lines for different flows are marked on the strip. This circular rule is based on the Williams-Hazen formula.

Another rule, but of rectangular type (Fig. 5), was prepared for use with the $H = CV^2$ type of formula. The rectangular rule provides a longer scale for head readings. These rules may also be used to facilitate the plotting of Freeman-type charts, as the head is to a natural scale and the loci of Q values may be picked off the chart. On this chart the Q–H relationship for a pipe, or system of pipes, is represented by a vertical line. The chart is dimensionless and various units of flow and head may be used. The pipe sizes (diameters in inches) shown on the upper chart locate Q–H lines, for the sizes indicated, that correspond to the Q–H given by the designated formula when the velocity is 3 fps. For these reference pipe sizes, the loss of head is in feet per thousand and flow in million gallons per day. By setting the index of slide rule at the pipe size desired, the location of the Q–H line for lengths of pipe other than 1000 ft. may be determined.

The elements of the hydraulic grade method are shown in Fig. 6. The top portion of this figure shows the hydraulic grade plotted for (A) 2000 ft., 10-in., $C = 80$ and (B) 1000 ft., 6-in., $C = 100$, in series. The grade may be plotted from data taken off the pipe flow diagrams. At the right of the hydraulic grade line are shown the two strips, with flows indicated thereon, placed on cross-section paper the ruling of which represents lost head. The characteristics of the series $A + B$ is shown to be a head of 76.4 for a flow of 1.00 mgd. From the slide rule or diagram, a strip may be made representing the combined pipe by plotting a strip on the line where 1 mgd. coincides with a head loss of 76.4.

The bottom portion of Fig. 6 illustrates the procedure with a loop.

Figure 7 shows the application of the hydraulic grade method to the network of Fig. 2. In the left portion the pipe system is shown by an isometric drawing to indicate the losses of head graphically. The right portion of the figure illustrates the application of Q/H strips for each branch. The graphical solution of this or similar problems by the hydraulic grade method, as illustrated in Fig. 7, is no doubt more time-consuming than the Hardy Cross method. It does, however, give a good picture of flow conditions in the system. For an existing system, the Q/H strips may be made in more permanent form of cardboard or celluloid and mounted in slides, so that flow data may be taken off rapidly.

Figure 8 illustrates an application of the method to a simple branch line, fed from two reservoirs at different elevations. If the reservoir elevations are constant, the Q/H scales do not require shifting and the flow at point C may be read off for any elevation of the hydraulic grade at C. The flows through each branch and the total flow are indicated directly. If the reservoir elevations are subject to change, slides may be used for line AC and BC and shifted so that the zero flow on each slide coincides with the elevation of the reservoir it serves. A slide for total

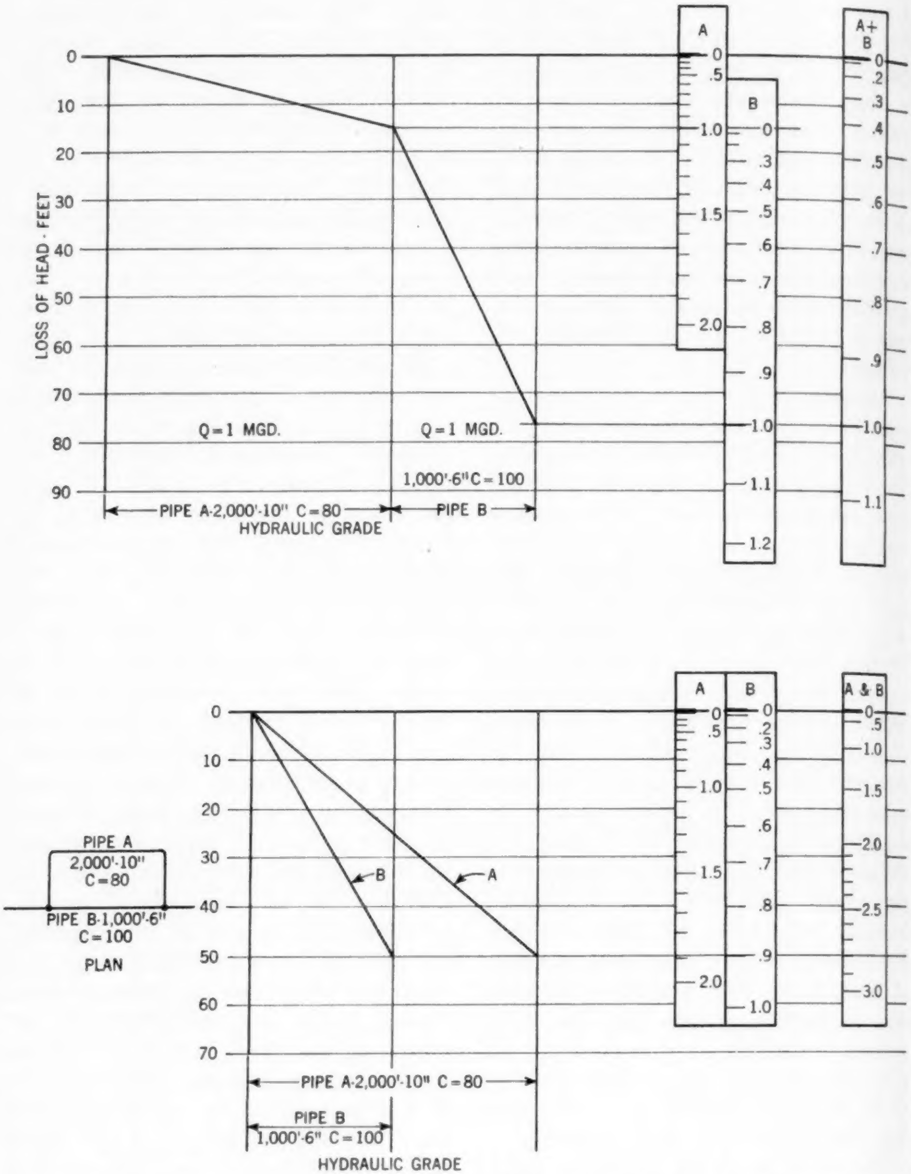

FIG. 6. Plottings of Hydraulic Grade: (*Top*) Compound Series Pipes; (*Bottom*) Compound Parallel Pipes

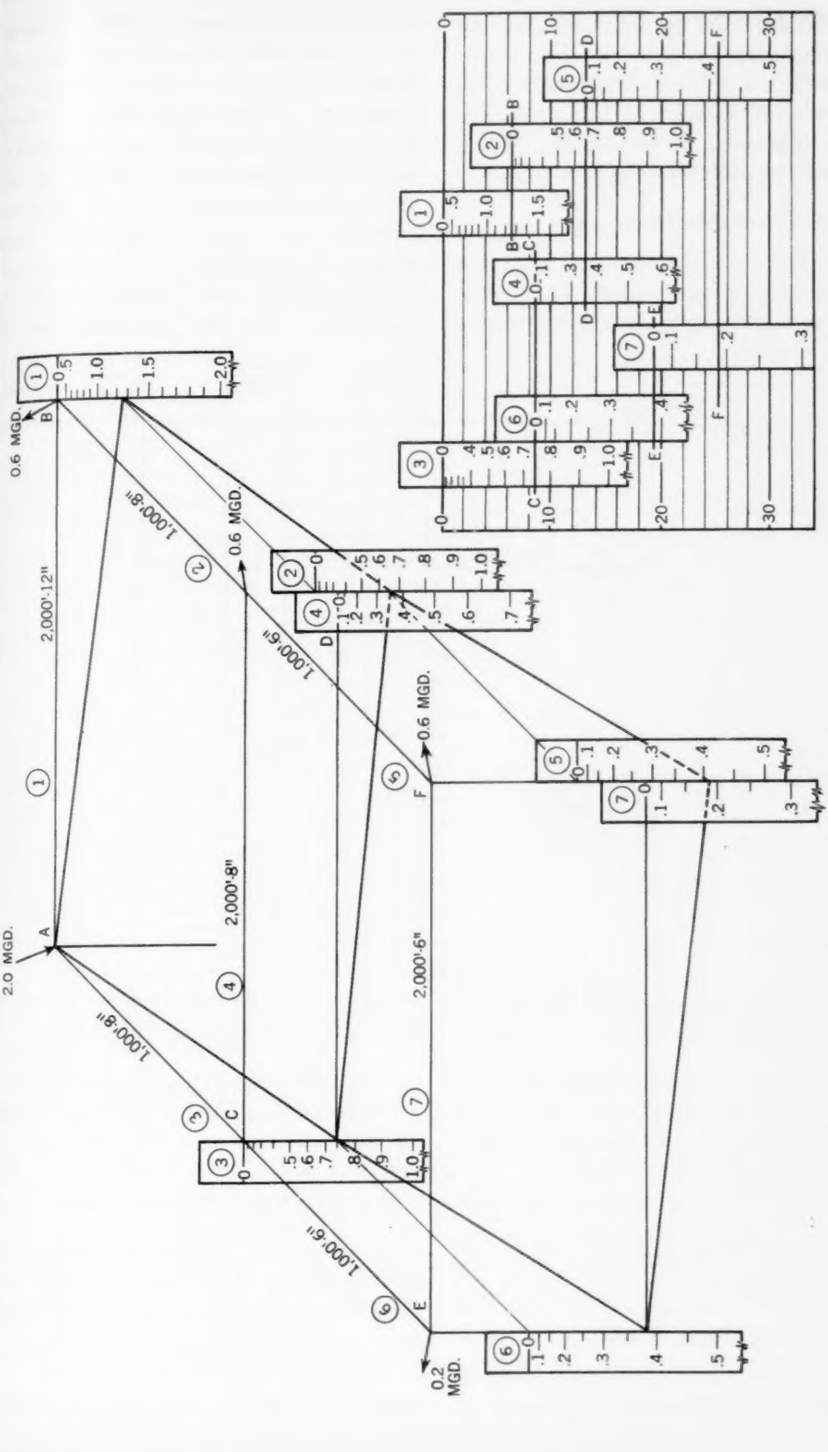

FIG. 7. Application of Hydraulic Grade Method to Network of FIG. 2: (*Left*) Isometric Drawing of Pipe System, showing losses of head; (*Right*) Application of *Q/H* Strips for each Branch

flow could not be used in this case, for all conditions, as a different slide would be needed for each combination of reservoir elevations. The total is readily obtained, however, by adding the flows in each line algebraically.

Hardy Cross Method

The Hardy Cross method uses the trial and error procedure, but corrections are determined mathematically rather than by guess, so that each trial comes closer to the correct value. A number of papers on this method have been published (2, 9, 13–20).

Conklin (21) has proposed a useful method of determining the first approximation of flows in any trial and error method.

Formula for Pipe Flow

For many years the question of what formula to use in computing flows in distribution systems caused little concern. One simply took the Williams-Hazen *Hydraulic Tables,* selected the coefficient C and read off the values for loss of head and flow. In recent years much has been written on the mechanics of turbulent flow and some writers on hydro-mechanics have spoken disparagingly of the crude empirical exponential formulas used by engineers. The present trend appears to be toward using a diagram with f as ordinate and **R** or Reynolds number as abscissa. One then proceeds to compute **R** or

$$\frac{VD}{\nu}\ \frac{(\text{Velocity} \times \text{Diameter})}{(\text{Kinematic viscosity})}$$

and, from the chart, pick off the f and then figure the H_f from the formula

$$H_f = \frac{fLV^2}{D2g}.$$

The value of this procedure for uni-

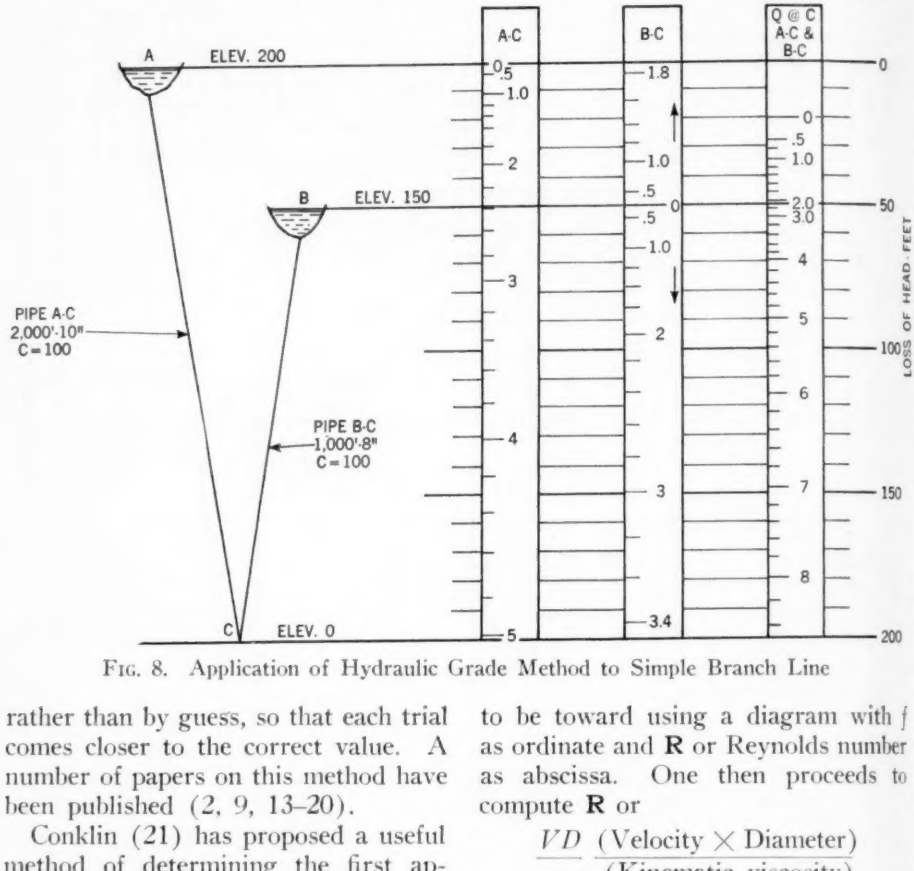

FIG. 8. Application of Hydraulic Grade Method to Simple Branch Line

versal application is shown by the fact that, for the same pipeline, coincident curves result from plotting f against **R** for both air and water.

Illustrations of this type of curve will be found in present day books on hydraulics and hydro-mechanics (22–27). It will be noted that there are three phases of flow conditions shown in these charts: (1) at low values of the Reynolds number (below $\mathbf{R} = 2000 \pm$), the flow is laminar and $H = CV$, or the head varies with the first power of the velocity; (2) an intermediate zone where $H = CV^n$ or head varies as V raised to some power, n, which ranges from 1.75 for very smooth pipe to 2.00 for very rough pipe; (3) the quadratic zone where $H = CV^2$ for all classes of pipe.

TABLE 1

Approximate Limits of Laminar, Exponential and Quadratic Flow Zones

Pipe Size		Critical Velocity $\mathbf{R} = 2000$	Approximate Velocity at Lower Limit of V^2 Zone					
Nominal Size	Actual Diam.		$\epsilon = 0.01$ cm.	$\epsilon = 0.02$ cm.	$\epsilon = 0.04$ cm.	$\epsilon = 0.08$ cm.	$\epsilon = 0.16$ cm.	$\epsilon = 0.32$ cm.
in.	*in.*	*fps.*	*fps.*	*fps.*	*fps.*	*fps.*	*fps.*	*fps.*
$\frac{1}{8}$	0.270	1.09	67	36	20	11	5.8	3.2
$\frac{1}{4}$	0.364	0.81	64	35	19	10	5.7	3.1
$\frac{3}{8}$	0.494	0.60	62	34	18	10	5.5	3.0
$\frac{1}{2}$	0.623	0.47	60	33	18	9.7	5.3	2.9
$\frac{3}{4}$	0.824	0.36	58	32	17	9.4	5.1	2.8
1	1.048	0.28	52	31	17	9.0	5.0	2.7
$1\frac{1}{4}$	1.380	0.21	46	30	16	8.8	4.8	2.6
$1\frac{1}{2}$	1.611	0.18	43	29	16	8.6	4.8	2.6
2	2.00	0.15	40	26	16	8.3	4.6	2.5
$2\frac{1}{2}$	2.50	0.12	36	24	15	8.1	4.5	2.4
3	3.00	0.10	33	22	15	7.8	4.4	2.4
4	4.00	0.074	29	20	13	7.7	4.2	2.3
5	5.00	0.059	27	18	12	7.5	4.1	2.2
6	6.00	0.049	25	17	11	7.3	4.0	2.2
8	8.00	0.037	22	15	10	6.5	3.9	2.1
10	10.00	0.030	20	13	9.0	6.0	3.7	2.0
12	12.00	0.025	18	12	8.3	5.5	3.7	2.0
14	14.00	0.021	17	12	7.7	5.1	3.5	1.9
16	16.00	0.018	16	11	7.3	4.9	3.3	1.9
18	18.00	0.016	16	10	7.0	4.7	3.1	1.9
20	20.00	0.015	15	10	6.7	4.5	3.0	1.9
24	24.00	0.012	14	9.2	6.2	4.1	2.8	1.8
30	30.00	0.010	13	8.4	5.6	3.8	2.5	1.7
36	36.00	0.008	12	7.8	5.2	3.5	2.3	1.6
42	42.00	0.007	11	7.3	4.9	3.3	2.2	1.5
48	48.00	0.006	10	6.9	4.6	3.1	2.1	1.4
54	54.00	0.005	9.7	6.6	4.4	2.9	2.0	1.3
60	60.00	0.005	9.3	6.2	4.2	2.8	1.9	1.3
72	72.00	0.004	8.6	5.8	3.9	2.6	1.7	1.2
84	84.00	0.003	8.1	5.4	3.6	2.5	1.6	1.1

Table 1 gives approximate values for the limits of these three zones for various pipe diameters in terms of velocity. It will be noted that the

TABLE 2

Q/H *Settings for Various Formulas at Velocity of 3 Feet per Second*

Nominal Size	Flow at 3 fps. Velocity	Loss of Head in Feet per Thousand											
		Schoder's Formulas				Williams-Hazen Formula				Quadratic Zone Nikuradse			
		$\frac{0.3V^{1.75}}{d^{1.25}}$	$\frac{0.38V^{1.86}}{d^{1.25}}$	$\frac{0.5V^{1.95}}{d^{1.25}}$	$\frac{0.69V^{2}}{d^{1.25}}$	$C = 140$	$C = 120$	$C = 100$	$C = 80$	$\epsilon = 0.04$ cm.	$\epsilon = 0.08$ cm.	$\epsilon = 0.16$ cm.	$\epsilon = 0.32$ cm.
in.	*gpd.*												
$\frac{1}{8}$	771	235	336	489	713	207	275	385	582				1920.
$\frac{1}{4}$	1,400	162	232	337	491	146	194	272	411				1090.
$\frac{3}{8}$	2,580	111	158	230	335	102	136	190	287				630.
$\frac{1}{2}$	4,100	82.8	118	172	251	77.9	104	145	219				427.
$\frac{3}{4}$	7,190	58.3	83.4	121	177	56.1	74.7	105	158				265.
1	11,600	43.2	61.8	89.8	131	42.5	56.5	79.1	120				180.
$1\frac{1}{4}$	20,100	30.6	43.8	63.6	92.7	30.8	40.9	57.4	86.7				117.
$1\frac{1}{2}$	27,400	25.3	36.1	52.4	76.5	25.7	34.2	47.9	72.4				92.8
2	42,300	19.3	27.5	40.0	58.3	20.0	26.5	37.2	56.2				66.9
$2\frac{1}{2}$	66,100	14.6	20.8	30.3	44.1	15.4	20.5	28.7	43.3				48.2
3	95,200	11.6	16.6	24.1	35.1	12.4	16.5	23.2	35.0				36.9
4	169,000	8.10	11.6	16.8	24.5	8.88	11.8	16.6	25.0				24.4
5	264,000	6.13	8.76	12.7	18.6	6.85	9.11	12.8	19.3				17.8
6	381,000	4.88	6.97	10.1	14.8	5.54	7.36	10.3	15.6			10.73	13.9
8	677,000	3.41	4.88	7.07	10.3	3.96	5.26	7.38	11.2			7.32	9.33
10	1,060,000	2.58	3.68	5.35	7.80	3.05	4.06	5.69	8.59			5.47	6.88
12	1,520,000	2.05	2.93	4.26	6.21	2.47	3.28	4.60	6.94			4.30	5.37
14	2,070,000	1.69	2.42	3.51	5.12	2.06	2.74	3.84	5.80			3.52	4.37
16	2,710,000	1.43	2.05	2.97	4.33	1.76	2.34	3.28	4.96			2.96	3.68
18	3,430,000	1.24	1.77	2.57	3.74	1.54	2.04	2.86	4.33			2.54	3.14
20	4,230,000	1.08	1.55	2.25	3.28	1.36	1.81	2.53	3.83			2.22	2.73
24	6,090,000	0.863	1.23	1.79	2.61	1.10	1.46	2.05	3.09			1.76	2.15
30	9,520,000	0.653	0.933	1.35	1.98	0.846	1.13	1.58	2.38		1.11	1.33	1.61
36	13,710,000	0.520	0.743	1.08	1.57	0.684	0.910	1.28	1.93		0.89	1.05	1.27
42	18,700,000	0.429	0.613	0.890	1.30	0.572	0.760	1.07	1.61		0.73	0.87	1.05
48	24,400,000	0.363	0.518	0.753	1.10	0.489	0.650	0.911	1.38		0.62	0.73	0.88
54	30,800,000	0.313	0.447	0.650	0.948	0.426	0.567	0.795	1.20		0.54	0.63	0.76
60	38,100,000	0.274	0.392	0.569	0.830	0.377	0.501	0.703	1.06		0.47	0.55	0.66
72	54,800,000	0.218	0.312	0.454	0.661	0.305	0.405	0.568	0.858	0.35	0.38	0.44	0.53
84	74,600,000	0.180	0.258	0.374	0.545	0.254	0.338	0.474	0.717	0.27	0.31	0.37	0.43

zone of viscous or laminar flow is below the range of common practice. Smaller pipes are found in the intermediate zone and larger pipes in the quadratic zone, depending on the roughness of the pipe. In this table, ϵ designates the radial dimension of the roughness particles in centimeters.

The values for the limits of the V^2 zone were obtained by exterpolating from Nikuradse's results. As Nikuradse's experiments were made on small pipe, these data are approximate and speculative for the larger sizes. Formulas for the laminar zone are exact, and theoretical formulas for smooth pipe appear to be well substantiated by experiment and theory. For rough pipe, as Daugherty (24) remarks: "So far no satisfactory theoretical equation, that is of universal application, has been developed."

In one textbook (25) an f–**R** chart shows various slopes for pipes of different classes. In an excellent booklet on the flow of fluids, published by the Crane Company (28), is a diagram, based on the work of Pigott (29) and Kemler (30), described as "probably the most complete and reliable data on friction factors for the general flow equation (Fanning's formula)." This shows the lines of different slopes intersecting at a point on the lower critical velocity, at approximately $\mathbf{R} = 1140$ and $f = 0.054$. Other similar charts show a different disposition of the curves for pipes of different roughness and size.

For this particular intermediate zone we have gone the long way around and figured **R** and then chosen from an assortment of exponential formulas to find f in order to do some more figuring to get H. Obviously it will be easier to get out the Williams-Hazen tables again to find the values.

Capen (31) in his paper on coefficients of large pressure pipes has suggested the use of the quadratic formula and has shown by tests of large pipelines that it applies to the lines tested. Table 1 also indicates that the V^2 formula includes or approaches a considerable portion of pipe sizes and velocities encountered in distribution system studies. If one formula is to be used, it seems logical to follow Capen's suggestion and use the V^2 type. For network problems by any method, the use of one formula is desirable. By using the V^2 type, computations are simplified and a common slide rule becomes a hydraulic slide rule. Capen uses a common slide rule with settings for his Mills' formula coefficients indicated thereon.

If a slide rule is to be used, the settings must be known for different pipe sizes and coefficients. Completely satisfactory data on this are lacking. The best method may be to use data with which one is familiar. For example, for smaller pipe sizes, the Q/H relationship from the Williams-Hazen formula for an average velocity of, for instance, 3 fps. could be used for the desired setting. Table 2 gives Q/H values for 3 fps. taken from the Williams-Hazen tables, Schoder's formulas and, for the fully turbulent zone, from Nikuradse's formula,

$$\frac{1}{\sqrt{f}} - 2 \log_{10} \frac{r_0}{\epsilon} = 1.74$$

where r_0 is the pipe radius and ϵ the radial dimension of the roughness particles. This table gives the loss of head in feet per thousand feet corresponding to the flow at 3 fps. velocity for various pipe sizes and formulas. The two values of Q and H provide a setting for the common slide rule.

Pipe Flow Analysis With Orifices

In commenting editorially upon the construction of a steel-domed building by George T. Horton, President of the Chicago Bridge and Iron Co., "for our own amusement," *Engineering News-Record* (32) advised its readers to "try things just for the hell of it." Spurred on by this high purpose, the writer has attempted to investigate the possibilities of a hydraulic analyzer for determining flows in pipe networks. This method promises no economy of time in solving an isolated problem, but a hydraulic model of an existing system of main lines could be of value in indicating losses for various flows.

As previously discussed, Capen (31) has presented the merits of the quadratic form of pipe flow formula. If this head-flow relationship is suitable and if submerged orifices showed the same relationship, it seems logical and practical to use orifices to represent pipes. If, as expected, the logarithmic plotting of head and rate of flow for orifice showed a slope of 2, a series of curves could be obtained that would coincide with the plotting on log paper of the head-flow relationship of the elements of a pipe network. If sufficient orifices were available so that a group of them could be chosen to match the plotting of the *Q–H* of the network pipes, the conversion factors for head and flow would be indicated when plottings of *H–Q* for orifices and pipe coincided.

To determine the possibilities of this plan, a number of small orifices were made and tested. Orifices were made by drilling sheet copper 0.0063 in. thick. The sizes of holes were determined by the drills available. The copper was cut into circular pieces approximately $\frac{3}{4}$ in. in diameter with the orifice in the center. Each plate was cemented between two washers, $\frac{3}{4}$ in. od. and $\frac{1}{2}$ in. id. and 0.13 in. thick. When tested and used in the model, the orifices were inserted in gum-rubber tubing in which they fitted snugly. Half-inch pipe, nipples and fittings were used for connecting the rubber tubing. Water supply was from a glass jar hung above the orifices and supplied by a hose connected to the faucet of a laundry tub on which the equipment was mounted. A rubber tube connected the bottom outlet of the glass jar with the orifices. When testing the orifices, the glass jar was hung at different elevations above them. Two or more orifices were tested at a time. Glass tubes connected by rubber tubing to tees preceding and following submerged orifices were mounted on a gage board. When steady flow was obtained, the heads on piezometers were marked on a paper tacked on the gage board. The rate of flow was determined by collecting the discharge in a volumetric cylinder in a given time as indicated by a stop watch. Flows were recorded in milliliters per minute and heads in inches. The data were plotted on logarithmic paper and indicated that the head varied with the square of the flow. Some 25 orifices were made, varying in size from 0.0413 to 0.134 in. in diameter. The test results were plotted on logarithmic paper.

The application of the orifices to a model was then attempted. The network shown in Fig. 2 was used. The *Q–H* curves for the network were plotted to slope of 2.0 using, for the location of each line, the head and flow from the Williams-Hazen formula, *C* = 100, for the pipe represented, at a

velocity of approximately 3 fps., as shown in Table 3.

TABLE 3

Characteristics of Network

Pipe No.	Length	Size	At Velocity of:	Q	H_f	H_f Total
	ft.	*in.*	*fps.*	*mgd.*	*ft./1000 ft.*	*ft.*
1	2,000	12	2.96	1.5	4.43	8.86
2	1,000	8	3.10	0.70	7.8	7.8
3	1,000	8	3.10	0.70	7.8	7.8
4	2,000	8	3.10	0.70	7.8	15.6
5	1,000	6	3.15	0.40	11.3	11.3
6	1,000	6	3.15	0.40	11.3	11.3
7	2,000	6	3.15	0.40	11.3	22.6

The plotting of the seven pipes noted in this table was superimposed on the plotting of the results of the orifice tests. The best match was obtained with the orifices shown in Table 4,

TABLE 4

Characteristics of Test Orifices

Pipe	Orifice No.	Diameter	Discharge Coef.	Q @ H = 12 in.	Q @ H = 12 ft.
		in.		*ml./min.*	*mgd.*
1	20	0.116	0.673	670	1.705
2	11	0.082	0.713	355	.903
3	12	0.081	0.726	355	.903
4	7	0.070	0.692	255	.649
5	4	0.054	0.738	158	.402
6	5	0.054	0.675	148	.377
7	3	0.047	0.709	117.5	.299
Outlets Free Discharge					
B	15	0.0966	0.733	510	1.298
D	16	0.0950	0.736	495	1.260
E	4	0.0528	0.699	145	0.369
F	14	0.0919	0.724	455	1.158

with inches head in the model representing feet head in the network and with 393 ml. per min. representing 1-mgd. flow. As exact coincidence of lines was not obtained with the orifice sizes available, the model did not exactly represent the system. The lengths corresponding to model orifices are approximately as follows:

Pipe No.	*Length, ft.*	*Size, in.*
1	2,090	12
2	925	8
3	925	8
4	1,780	8
5	1,060	6
6	1,200	6
7	1,910	6

The choice of orifices for determining the quantity of discharge was not critical. Orifices were selected that would give a reasonable head at the desired flows. A scale was made for each orifice, indicating the rate of flow directly in million gallons per day. In preparing these scales, the same conversion factors were used as for submerged orifices, i.e., inches head = feet head and 393 ml. = 1 mgd.

The assembly of the apparatus is shown in Fig. 9, which is a photograph looking down on the equipment placed on the floor. Orifices are in the short rubber tubes between fittings. String was tied around the orifices to insure tightness. The fittings were secured to a light wood frame which was placed over laundry tub when testing. A gage board secured to the frame supported the gage glasses. Cardboard scales attached to the orifices for free discharge at corners *B*, *D*, *E* and *F* indicated flow in million gallons per day. When a run was made, the water was allowed to overflow the glass jar feeding the system (not shown in the figure) to provide constant head. The desired rates of flow were established by adjusting pinchcocks at the outlet orifices. When flow was as steady as possible, the height of water in each piezometer was measured from

TABLE 5

Record of Runs With Hydraulic Analyzer

Outflow at:				Total Flow	Flow in Pipe, mgd.							Loss of Head in Pipe, ft.						
B	D	E	F		1	2	3	4	5	6	7	1	2	3	4	5	6	7
0.6	0.6	0.2	0.6	2.0	1.30	0.64	0.78	0.37	0.42	0.39	0.18	7.03	6.00	9.03	4.00	13.00	12.67	4.33
0.6	0.6	0.2	0.6	2.0	1.22	0.65	0.75	0.37	0.40	0.37	0.18	6.19	6.19	8.38	4.00	12.00	11.50	4.50
0.6	0.6	0.2	0.6	2.0	1.28	0.67	0.80	0.37	0.43	0.41	0.16	6.75	6.63	9.50	3.88	13.75	14.00	3.63
0.6	0.4	0.2	0.6	1.8	1.11	0.52	0.67	0.30	0.40	0.35	0.17	5.13	4.00	6.63	2.50	12.19	10.63	4.06
0.6	0.6	0.2	0.4	1.8	1.16	0.56	0.67	0.36	0.27	0.29	0.11	5.56	4.69	6.56	3.69	5.38	7.32	1.75
0.4	0.6	0.2	0.6	1.8	1.07	0.65	0.73	0.34	0.41	0.36	0.18	4.69	6.31	7.75	3.25	12.31	11.13	4.43
0.57	0.60	0.14	0.57	1.88	1.21	0.60	0.72	0.36	0.38	0.33	0.19	6.00	5.375	7.625	3.75	10.50	9.375	4.875
0.62	0.60	0.19	0.60	2.01	1.28	0.64	0.77	0.37	0.41	0.38	0.19	6.75	6.00	8.75	4.00	12.75	12.00	4.75
0.60	0.60	0.21	0.60	2.01	1.28	0.64	0.78	0.37	0.41	0.38	0.17	6.75	6.00	8.875	3.875	12.75	12.50	4.125
0.62	0.59	0.29	0.59	2.09	1.30	0.68	0.82	0.36	0.45	0.43	0.14	7.00	6.75	10.00	3.75	14.813	15.75	2.813
0.52	0.50	0.29	0.65	1.96	1.19	0.65	0.80	0.31	0.49	0.46	0.16	5.875	6.315	9.375	2.815	18.12	17.625	3.31
0.59	0.59	0.20	0.66	2.04	1.30	0.67	0.81	0.37	0.46	0.41	0.20	7.00	6.625	9.625	4.00	15.625	14.185	5.44
0.61	0.81	0.21	0.60	2.23	1.41	0.77	0.87	0.45	0.41	0.40	0.18	8.19	8.81	11.25	5.75	12.375	13.625	4.50
0.98	0.60	0.17	0.61	2.36	1.60	0.58	0.84	0.42	0.41	0.39	0.19	10.625	4.875	10.375	5.125	12.375	12.875	4.625
1.06	0.0	0.0	0.0	1.06	0.83	0.26*	0.26	0.17	0.04*	0.05	0.06	2.875	1.000*	1.000	0.875	0.125*	0.25	0.50
0.0	1.20	0.0	0.0	1.20	0.67	0.69	0.54	0.40	0.13*	0.12	0.12	1.875	6.935	4.25	4.56	1.185*	1.31	2.065
0.0	0.0	0.0	0.71	0.71	0.39	0.33	0.37	0.09	0.45	0.27	0.26	0.625	1.625	2.00	0.25	15.00	6.00	9.25
0.0	0.0	0.43	0	0.43	0.21	0.22	0.25	0.05*	0.17	0.28	0.18*	0.19	0.69	0.94	0.06*	2.25	6.81	4.62*
0.0	0.0	0.0	0.77	0.77	0.39	0.34	0.37	0.10	0.46	0.27	0.27	0.63	1.75	2.065	0.315	15.56	6.25	9.625
0.0	0.75	0.0	0	0.75	0.43	0.42	0.34	0.24	0.08*	0.07	0.08	0.75	2.63	1.69	1.69	0.44*	0.44	0.81
1.16	0.0	0.36	0	1.52	1.07	0.09*	0.47	0.21	0.14	0.25	0.14*	4.75	0.125*	3.315	1.31	1.375	5.185	2.50*
0.0	0.0	0.20	0.61	0.81	0.41	0.39	0.44	0.07	0.45	0.37	0.16	0.685	2.25	2.81	0.125	15.185	11.875	3.435
0.0	0.63	0.22	0.47	1.32	0.67	0.69	0.65	0.30	0.35	0.35	0.11	1.88	6.935	6.315	2.50	9.375	10.125	1.75

* Flow in reverse direction.

a reference line on the gage board. The loss of head for each orifice was computed from the observed heads on piezometers and, from the loss of head, the rate of flow was found from a plotting of Q–H in million gallons per day and feet head for each orifice. On many runs the outflow was checked by measuring the flow in milliliters per minute, and converting to million gallons per day by dividing the value in milliliters per minute by 393. The results of a number of runs, as shown in Table 5, are not precise, but indicate that the method has possibilities for useful application.

There are several possibilities for error, such as, clogging of orifices, separation of air and change of flow during a run. All runs were made single-handed. The separation of air from the water was particularly troublesome during warm weather, when enough air would separate out in the system in a few minutes to cause error. The best plan no doubt would be to recirculate de-aerated water by means of a pump.

It will be noted that Table 4 gives the discharge coefficients. These values were not used in the tests, but were computed as a matter of interest.

The exact sizes of the orifices were determined by making camera lucida drawings of the orifices with a microscope and indicating a scale from a stage micrometer on the drawings. The areas were then planimetered and the actual areas of openings computed from the magnification. The diameters of orifices shown in Table 4 were calculated from the actual area determined as described. The values of discharge coefficient for orifices submerged and with discharge to air are as follows:

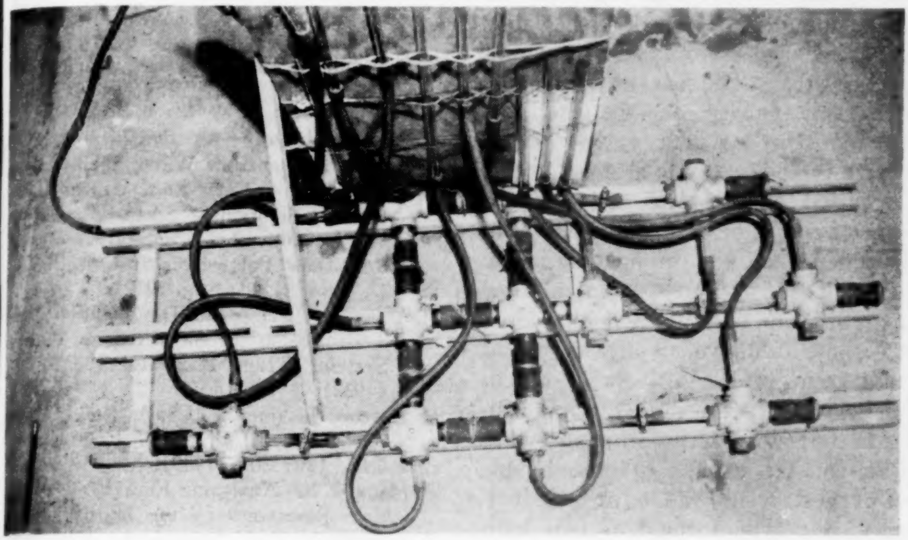

FIG. 9. Assembly of Apparatus for Crifice Method

	Submerged	*Free Discharge*
Average	0.709	0.726
Median	0.7085	0.7255
Maximum	0.739	0.766
Minimum	0.641	0.68
No. of orifices tested	24	22

When the orifices were observed under the microscope, it was noted that the edges were quite rough and jagged. This no doubt contributed to the variations in the values of discharge coefficients.

This method has a disadvantage in that, even with a large number of orifices, it is difficult to select the exact sizes needed to represent a pipe network. With proper tools and careful work, orifices could be prepared to the exact size needed, using a needle file for reaming to that size, but, unless a permanent model is needed, the labor of making orifices to exact size would be excessive. The use of adjustable orifices or valves may be the best method. Hard rubber valves of the petcock type, obtainable at drug stores, were tried. The valves tested had a connection opening approximately $\frac{1}{4}$ in. in diameter and a $\frac{5}{32}$-in. opening in the cock. Tests indicated that a flow range of 80 to 1200 ml. per min. could be obtained with valves of this size at about 12 in. head. Adjustable orifices could easily be set to the required opening by testing in series with an orifice of known size, using a calibrated gage.

For best results an adjustable orifice of the type formed of two half-squares closing on a common diagonal, thus giving a square opening of variable size, is indicated. The apparatus described was made up of materials that could be readily obtained. Refinements such as glass cylinders, with four connections for orifices at the bottom to serve as pipe junctions, would indicate the head at these points and permit escape of air. Unions of ample size to enclose orifice plates and similar improvements would simplify operation and increase accuracy.

References

1. Camp, Thos. R. & Hazen, H. L. Hydraulic Analysis of Water Distribution Systems by Means of an Electric Network Analyzer. J.N.E.W.W.A., **48**: 383 (1934).
2. Fair, Gordon M. Hydraulic Investigation of Water Distribution Systems in Field and Office. J.N.E.W.W.A., **55**: 271 (1941).
3. Howland, W. E. Expansion of the Freeman Method for the Solution of Pipe Flow Problems. J.N.E.W.W.A., **48**: 408 (1934).
4. Freeman, John R. Arrangement of Hydrants and Water Pipes for Fire Protection. J.N.E.W.W.A., **7**: 49, 152 (1892–93).
5. Kingsbury, Francis H. Capacity of Twin Pipe Line. Eng. News, **76**: 1239 (1916).
6. Palsgrove, Grant K. Graphical Analysis of a Dual-Flow Water Supply System. Eng. News-Rec., **107**: 422 (1931); Solution of Special Problems in Pipe Flow by Graphical Analysis. Rensselaer Polytechnic Inst. Bul. No. 37, Troy, N.Y. (Aug. 1932).
7. Aldrich, Ellwood H. Solution of Transmission Problems of a Water System. Trans. A.S.C.E., **103**: 1579 (1938).
8. Novoro, Joseph A. Charts Solve Multiple-Reservoir Problem. Eng. News-Rec., **129**: 300 (1942).
9. Muir, J. F. Analyzing Flow From Multiple Reservoirs by the Hardy Cross Method. Eng. News-Rec., **128**: 408 (1942).
10. Williams, Gardner S. & Hazen, Allen. *Hydraulic Tables.* John Wiley, New York (1905, 1908, 1920).
11. Tyler, Richard G. Flow of Water in Pipe Grid Systems. W.W. & Sew., **86**: 285 (1939).
12. Howland, W. E. & Farr, F., Jr. Computation of Equivalent Lengths of Parallel Pipe Systems. Jour. A.W.W.A., **33**: 237 (1941).
13. Cross, Hardy. Analysis of Flow in Networks of Conduits or Conductors. Eng. Expt. Station, Univ. of Illinois, Bul. No. 268 (Nov. 13, 1936).

14. DOLAND, J. J. Simplified Analysis of Flow in Water Distribution Systems. Eng. News-Rec., **117**: 475 (1936).

15. FAIR, GORDON M. Analyzing Flow in Pipe Networks. Eng. News-Rec., **120**: 342 (1938).

16. HURST, C. K. Distribution System Analysis in Edmonton. Jour. A.W.W.A., **32**: 2038 (1940).

17. DOLAND, J. J. Flow and Loss of Head in Distribution Systems. Jour. A.W.W.A., **33**: 234 (1941).

18. FARNSWORTH, GEORGE, JR. & ROSSANO, AUGUST, JR. Application of the Hardy Cross Method to Distribution System Problems. Jour. A.W.W.A., **33**: 224 (1941).

19. HURST, W. D. & BUBBIS, N. S. Application of the Hardy Cross Method to the Analysis of a Large Distribution System. Jour. A.W.W.A., **34**: 247 (1942).

20. SLIGHT, GEORGE M. Chart for Balancing Pipe Head Losses by the Hardy Cross Method. Eng. News-Rec., **128**: 41 (1942).

21. CONKLIN, JAMES A. Flow in Pipe Networks by Direct Determination. Eng. News-Rec., **127**: 370 (1941).

22. BAKHMETEFF, BORIS A. *The Mechanics of Turbulent Flow.* Princeton University Press (1941).

23. ROUSE, HUNTER. Modern Conceptions of the Mechanics of Fluid Turbulence. Trans. A.S.C.E., **102**: 463 (1937).

24. DAUGHERTY, R. L. *Hydraulics.* McGraw-Hill, New York (1937).

25. O'BRIEN, MORROUGH P. & HICKOX, GEORGE H. *Applied Fluid Mechanics.* McGraw-Hill, New York (1937).

26. JAMESON, ALEX. H. *An Introduction to Fluid Mechanics.* Longmans, Green, New York, (1937).

27. COVIL, WILLIAM F. Alignment Charts for the Design of Pipe Lines. J.N.E. W.W.A., **53**: 103 (1939).

28. *Flow of Fluids.* Technical Paper No. 409. Crane Co., Chicago (May 1942).

29. PIGOTT, R. J. S. The Flow of Fluids in Closed Conduits. Mech. Eng., **55**: 497 (1933).

30. KEMLER, EMORY A. Study of Data on the Flow of Fluids in Pipes. Trans. A.S.M.E., **55**: HYD. 552 (1933).

31. CAPEN, CHARLES H. Trends in Coefficients of Large Pressure Pipes. Jour. A.W.W.A., **33**: 1 (1941); *Discussion.* Jour. A.W.W.A., **34**: 523 (1942).

32. Just for Fun. *Editorial.* Eng. News-Rec., **127**: 638 (1941).

Identical Value Method for Solving Simple Pipe-Flow Problems

By A. A. Hirsch

SHORT CUTS in calculation, particularly when workable without recourse to handbooks or tables and in many instances by mental arithmetic, are always desirable. The technique demonstrated below was developed originally as a simplification for plant operators.

Many formulas of frequent occurrence in water supply hydraulics are of the type:

$$y = kx^n z^m \ldots\ldots\ldots (A)$$

in which k is the proportionality constant, x and z are factors and n and m are constant exponents. Quite commonly a second factor does not appear, the relation being simply:

$$y = kx^n \ldots\ldots\ldots\ldots (B)$$

To solve this formula the values of k and n must be known.

In the method proposed below, the formula is recast into the form of a ratio, hence the explicit value of k is not needed. Apt use is made of a particular ratio based on knowing the value of x at which $y = x$. This special value of the independent factor which numerically equals the dependent variable is termed the "identical value." Denoting identical values by the subscript i:

$$y_i = x_i \ldots\ldots\ldots\ldots (C)$$

Substituting in Eq. B:

$$x_i = k^{(1/1-n)} \ldots\ldots\ldots (D)$$

The value of y corresponding to any value of x may then be computed from:

$$y = \left(\frac{x}{x_i}\right)^n y_i \ldots\ldots\ldots (E)$$

Since the identical values of x_i and y_i are readily retained in the memory, this method of calculation is useful for rapid checking and estimating. When more than a single independent variable comprises the formula, as in Eq. A, all other factors are held at unity in determining the identical value.

It is evident from Eq. D that this procedure is untenable only in the case where $n = 1$. As this is the simplest relation possible between two quantities, namely, that of direct proportion of first powers, no defeat of purpose is caused by this inapplicability. In such a case there is no such quantity as an identical value because y is always a factor times x.

The principles of the identical value method may be summarized as follows:

1. Know the physical law of variation; other powers than the first must be involved.

A contribution by A. A. Hirsch, Instructor in Water Purif., State Dept. of Education, Baton Rouge, La.

2. Determine the special value of the independent variable numerically equal to the item to be calculated.

3. Use this identical value directly in a bare factorial type equation.

These principles, decidedly simpler to apply than judged from their theoretical basis, are demonstrated below in the following commonly occurring calculations:

A. Volume of pipeline or tank
B. Velocity of flow in pipelines
C. Orifice discharge
D. Theoretical pump horsepower
E. Overall pumping efficiency
F. Pipe friction.

Although the above applications are drawn exclusively from the field of pipe flow and pumping this method of attack may be advantageously employed in connection with most other factorial type formulas. It will be noted, however, from the examples, that individual problems vary in their amenability to this scheme.

A. Volume of Pipeline or Tank

This calculation is made when figuring such problems as hypochlorite quantity for sterilizing newly laid mains and displacement time at any flow rate. The volume of a cylinder is given by:

$$v = 0.785\left(\frac{d}{12}\right)^2 \times 7.5 \times L \quad (1)$$

in which:

v = volume, in gal.
d = diameter, in in.
L = length, in ft.

Simplifying:

$$v = 0.04088d^2L \quad (2)$$

Find the size of pipe whose diameter, in inches, numerically equals the gallons capacity per foot of length, i.e:

$$\left.\begin{aligned} d &= v \\ L &= 1 \end{aligned}\right\} \quad (3)$$

Substituting conditions of Eq. 3 in Eq. 2:

$$\begin{aligned} d &= 0.04088d^2 \times 1 \\ &= 24.5 \text{ in.} \end{aligned} \quad (4)$$

This relation states that, for a hypothetical 24.5-in. pipe, the gallonage per foot equals the diameter. Since 24.5 is an odd figure, the value 24 may be substituted without appreciable error for most applications; if desired a 2 per cent correction may be subtracted from the answer. This equality may be remembered and applied with greater facility than the fundamental Eq. 1 or its simplified form Eq. 2. Derived originally to work out this specific problem, the identical value method was extended to other related applications once its facility was realized.

Example: How many gallons are contained in 300 ft. of 6-in. pipe?

Solution: The identical value and the conditions of the problem are substituted in the simple law of variation and the result obtained mentally. The factorial divisibility of this particular identical value makes the present problem unusually easy:

$$v \propto d^2L$$

Substituting the square of the ratio of the diameters, the identical value and the given length:

$$\begin{aligned} v &= \left(\frac{6}{24}\right)^2 \times 24 \times 300 \\ &= 450 \text{ gal.} \end{aligned}$$

B. Velocity of Flow in Pipelines

This value is found when determining retention time, velocity head, Reynolds number, pipe sizes and main

loadings. The usual formula is:

$$V = \frac{Q}{A} = \frac{\dfrac{q}{7.48 \times 60}}{0.785\left(\dfrac{d}{12}\right)^2} \quad \ldots (5)$$

$$= \frac{0.408q}{d^2} \quad \ldots\ldots\ldots\ldots (6)$$

in which:

V = velocity, in fps.
Q = discharge, in cfs.
q = discharge, in gpm.
d = pipe diameter, in in.
A = cross-sectional area, in sq.ft.

Find the size of pipe whose diameter, in inches, numerically equals the velocity of flow, feet per second, at 1 gpm. discharge, that is, when:

$$\left.\begin{aligned} d &= V \\ q &= 1 \end{aligned}\right\} \quad \ldots\ldots\ldots (7)$$

Substituting in Eq. 6:

$$d = \frac{0.408 \times 1}{d^2}$$
$$= 0.74 \text{ or } \tfrac{3}{4}\text{-in. pipe} \quad \ldots (8)$$

Hence, in a $\frac{3}{4}$-in. pipe, flowing 1 gpm., the velocity, in feet per second, is numerically the same as the pipe diameter, in inches. This is an easy fact to remember; its application is likewise simple.

Example: At what velocity does water flow in a 4-in. main, passing 200 gpm.?

Solution: Using the simple law of variation:

$$V \propto \frac{q}{d^2}$$

numerical values are substituted; the proper positions in the ratios are apparent from inspection:

$$V = \left(\frac{\frac{3}{4}}{4}\right)^2 \times \tfrac{3}{4} \times 200$$
$$= 5.3 \text{ fps.}$$

C. Orifice Discharge

Since the sharp-edged orifice is widely used in metering large flows, a simple mnemonic device for quick calculation is desirable. Discharge is given by the familiar relation:

$$Q = AV$$

$$q = 0.785\left(\frac{d}{12}\right)^2 c\sqrt{2gH} \times 7.48 \times 60 \quad \ldots (9)$$

where:

Q = discharge, in cfs.
q = discharge, in gpm.
A = area of orifice, in sq.ft.
d = diameter of orifice, in in.
V = velocity through orifice, in fps.
H = pressure drop across orifice, in feet of water; taps are located at 0.8 pipe diameter upstream and 0.4 diameter downstream from orifice; ratio of orifice size to pipe diameter should be not greater than 1 : 5.

Substituting the experimental value 0.61 for the coefficient c, and setting $\sqrt{2g} = 8.025$, the foregoing expression simplifies to:

$$q = 11.97d^2\sqrt{H} \quad \ldots\ldots (10)$$

To employ the identical value principle, find the size of the orifice, in inches, numerically equal to the flow, in gallons per minute, at unit head in feet, that is:

$$\left.\begin{aligned} d &= q \\ H &= 1 \end{aligned}\right\} \quad \ldots\ldots\ldots (11)$$

whence:

$$d = 11.97d^2\sqrt{1}$$
$$= 0.0835 \text{ in., or } \tfrac{1}{12} \text{ in.} \ldots (12)$$

Hence, a $\frac{1}{12}$-in. orifice passes a like number of gallons at 1 ft. differential.

Example: How much water passes through a $\frac{1}{2}$-in. orifice at a 100 ft. differential?

Solution: The law of variation is:

$$q \propto d^2\sqrt{H}$$

Substituting the numerical quantities, the statement becomes:

$$q = \left(\frac{\frac{1}{2}}{\frac{1}{12}}\right)^2 \times \tfrac{1}{12} \times \sqrt{100}$$
$$= 30 \text{ gpm.}$$

In general, problems involving roots and fractional exponents are not subject to mental arithmetic; the perfect root in the example is exceptional.

D. Theoretical Pump Horsepower

This quantity must be calculated when choosing motor sizes to pump water and when checking pump efficiencies. Although the application here is not typically an identical value formulation in the strictest sense, it bears certain resemblances and is included because of its utility and because the simplified formula contains round figures. The basic definition of the horsepower:

$$\text{hp.} = \frac{33{,}000 \text{ ft-lb.}}{\text{min.}}$$

becomes, when substituting the quantities involved when lifting water:

$$\text{hp.} = \frac{\text{gpm.} \times 8.33 \times H}{33{,}000} \quad \text{..(13)}$$

where H is the total dynamic head in feet. Dividing out constants:

$$\text{hp.} = 0.0002514 \text{ gpm.} \times H$$
$$= \frac{\text{gpm.} \times H}{3962} \quad \text{...........(14)}$$

that is, unit horsepower is indicated for every 3962 in the gpm. $\times H$ product, or, from the basis of unit head, a horsepower is equivalent to 3962 gpm. at 1 ft. head. The constant may be rounded out to 4000, with only -1 per cent error, to give:

$$\text{hp.} = \frac{\text{gpm.} \times H}{4000} \quad \text{.....(15)}$$

Example: Find the horsepower delivered to water flowing at 350 gpm. against a 120-ft. head.

Solution:

$$\text{hp.} = \frac{350 \times 120}{4000}$$
$$= 10.5$$

E. Overall Efficiency

The so-called wire-to-water efficiency is useful in checking performance of pumping units for acceptance, routine observations, trouble location and replacement comparisons. Calculation is made here by an adaptation of the identical value method to give an identical value to a reciprocal quantity in order to utilize instrumentation directly. In actual use this method, except, possibly, the final variation, possesses no special advantage over the conventional solutions. It does, however, illustrate the flexibility of the identical value method in embracing special features of a problem.

By definition:

$$\% \text{ Efficiency} = \frac{\text{output hp.}}{\text{input hp.}} \times 100$$

From the preceding section:

$$\text{Output hp.} = \frac{\text{gpm.} \times H}{3962}$$

Input is most readily obtainable from readings of a kilowatthour meter, dividing the total kilowatthours for any interval by the number of hours to obtain the power input. Since 0.746 kw. = 1 hp:

$$\text{Input hp.} = \frac{\text{kwhr.}}{\text{hr.} \times 0.746}$$

hence:

$$\% \text{ Eff.} = \frac{\dfrac{\text{gpm.} \times H}{3962}}{\dfrac{\text{kwhr.}}{\text{hr.} \times 0.746}} \times 100$$

$$= \frac{0.01881 \text{ gpm.} \times H \times \text{hr.}}{\text{kwhr.}} \quad (16)$$

By allowing the pump to run until the number of kilowatthours metered equals the product:

$$\frac{0.01881 \times \text{gpm.} \times H}{60}$$

the efficiency is given by the number of minutes of operation. Knowing the pumping rate and the total head, it is possible, by this method, to obtain efficiency values directly from a switchboard instrument and a watch, thereby facilitating a periodical check on overall efficiency. This method is directly applicable to deep well pumps charging into ground storage reservoirs. The head in this case is the average between high and low reservoir levels, corrected for pipe friction, and flow, in gallons per minute, can be obtained by noting the displacement at times during the test. For high service pumps charging elevated storage tanks, the test is best performed during night hours when consumption is at a minimum and may be allowed for, in some cases, by observing the rate of drop in the elevated tank level with the service pump off. Whenever possible, direct determination of total dynamic head at the pump and determination of flow, in gallons per minute, by positive measurement are desirable.

A reciprocal method for determining pump efficiency follows from the relations in Eq. 16. If the hours of run are made to equal:

$$\frac{1}{0.01881 \text{ gpm.} \times H}$$

then:

$$\% \text{ Eff.} = \frac{1}{\text{kwhr.}}$$

and efficiency is obtained simply by taking the reciprocal of the switchboard reading. In practical use, the time interval required is so small, due to the reciprocal relationship, that some multiple, e.g., 1000 times the indicated time, is run, with a corresponding correction in the answer.

A still simpler method for determining efficiency, requiring only the measurement of pumpage corresponding to a certain kilowatthour consumption may be developed if, in Eq. 16, rewritten below:

$$\% \text{ Eff.} = \frac{0.01881 \text{ gpm.} \times H \times \text{hr.}}{\text{kwhr.}}$$

delivery is continued until:

$$\text{kwhr.} = \frac{0.01881}{\text{min.}} \times H \times \text{hr.}$$

$$= \frac{0.01881}{60} \times H$$

$$= 0.0003135H \quad (17)$$

then:

$$\% \text{ Eff.} = \text{gal. pumped}$$

Obviously the time intervals and quantity pumped are too small for practical measurement, so 1000-fold values are used, and the relations become:

$$\text{kwhr.} = 0.3135H \quad (18)$$

and:

$$\% \text{ Eff.} = \frac{\text{gal. pumped}}{1000} \quad (19)$$

Example: How many kilowatthours must be consumed before reading the pumpage to obtain directly the efficiency of a pump delivering against a 140-ft. overall head? If 50,000 gal.

were pumped, what is the overall efficiency?

Solution: Using relations in Eqs. 18 and 19:

$$\begin{aligned}\text{kwhr.} &= 0.3135 \times 140\\ &= 43.9\\ \%\ \text{Eff.} &= 50{,}000/1000\\ &= 50\%\end{aligned}$$

F. Pipe Friction

Application of the identical value method to calculation of friction loss in pipe is hampered by the odd values of exponents. If a log-log slide rule is used, however, this difficulty disappears. In the familiar Williams-Hazen formula:

$$V = 1.318CR^{0.63}S^{0.54} \quad \ldots\ldots(20)$$

where:

V = velocity of flow, in fps.
C = coefficient of roughness
R = hydraulic radius, in ft.
S = hydraulic slope, in ft./ft.

Let:

Q = rate of flow, in mgd.
d = pipe diameter, in in.
h = head loss, in ft./1000 ft. length

then:

$$V = \frac{1{,}000{,}000Q}{7.48 \times 60 \times 60 \times 24 \times 0.785\left(\dfrac{d}{12}\right)^2} = \frac{284Q}{d^2}$$

$$R = \frac{\text{area}}{\text{wetted perimeter}} = \frac{\dfrac{\pi}{4}\left(\dfrac{d}{12}\right)^2}{\pi\dfrac{d}{12}} = \frac{d}{48}$$

$$S = \frac{h}{1000}$$

Substituting in Eq. 20, and solving for h:

$$h^{0.54} = 1000^{0.54} \times 284\frac{Q}{d^2} \times \frac{1}{1.318C \times \dfrac{d^{0.63}}{48^{0.63}}}$$

whence:

$$h = 1{,}908{,}000{,}000\frac{Q^{1.85}}{C^{1.85}d^{4.87}} \quad \ldots(21)$$

To apply the identical value method, find the pipe diameter in inches equal numerically to the head loss in feet per thousand feet length at a 1-mgd. rate, with C arbitrarily taken as 100, that is, in Eq. 21 make:

$$\left.\begin{aligned} d &= h\\ Q &= 1\\ C &= 100\end{aligned}\right\} \quad \ldots\ldots\ldots(22)$$

thereby obtaining:

$$\begin{aligned} d &= 1{,}908{,}000{,}000\frac{1^{1.85}}{100^{1.85}d^{4.87}}\\ &= 8.95 \quad \ldots\ldots\ldots\ldots\ldots\ldots(23)\end{aligned}$$

Hence, for a hypothetical pipe, nearly 9 in. in diameter, the friction loss in feet per thousand feet length at a 1-mgd. rate is equal to the size.

Since rounding out the identical value to an even 9 in. will incur an error of only 3 per cent, this approximation is usually permissible. Because of the high power of the diameter appearing in the formula, however, ratios of absolute rather than nominal diameters should be taken whenever possible. Simple integral exponents may not be substituted in this method without causing marked error, except when the ratios approach unity in value. If the ratio of diameters is raised to an even fifth power, a 20 per cent negative error in head loss results in calculating friction in a 48-in. pipe.

Example: Calculate the friction loss in 4000 ft. of 12-in. pipe, $C = 100$, discharging 2 mgd.

Solution: The law of variation is:

$$h \propto \frac{Q^{1.85}}{d^{4.87}}$$

Write a statement including the identical value and proper powers of the ratios concerned:

$$h = \left(\frac{2}{1}\right)^{1.85} \times \left(\frac{8.95}{12}\right)^{4.87} \times 8.95 \times 4$$

$$= 30.9 \text{ ft.}$$

which is in close agreement with a solution taken from charts.

If desirable, allowance for variation in the value of C may also be included, by inserting the ratio $\left(\frac{100}{C_{\text{problem}}}\right)^{1.85}$ in the statement.

For convenience in solving the above powered ratios, markers can be scribed on the *CI* scale of a log-log slide rule at the value of the two exponents, 1.85 and 4.87. These points set over the value of the corresponding ratios on the log-log scale locate the power value of the fraction on the log-log scale opposite the index of the *CI* scale.

Summary

The identical value method as developed above solves factorial type problems by noting the specific value where independent and dependent variables are numerically equal, instead of using the conventional formula constants. Application of this technique to pipe-flow problems has been given for illustration, and identical values have been demonstrated as follows:

A. A 24-in. pipe holds a like number of gallons per foot length.

B. In a $\frac{3}{4}$-in. pipe, flowing 1 gpm., the velocity, in feet per second, numerically equals the pipe diameter.

C. A $\frac{1}{12}$-in. sharp-edged orifice passes a like number of gallons per minute at a 1-ft. differential.

D. Unit water horsepower corresponds to every 4000 in the gallons per minute times head-foot product.

E. By running a pump until the kilowatthours consumed equal 0.3135 times the total head-feet, the overall efficiency is given by the thousands of gallons pumped.

F. An 8.95-in. (nearly 9-in.) pipe produces a like loss of head, in feet per thousand feet length, at a 1-mgd. rate, when $C = 100$.

The above values are used in a direct numerical statement based on the law of variation involved. Advantages of this method are directness, simplicity and ease of retention by memory.

Effect of Water Waste on Power Consumption

By Homer E. Beckwith

WHAT a difference just a few short months can make! It seems only yesterday that we were struggling through the difficult thirties cutting expenses here and there, saving wherever possible to make income meet outgo. Plant capacities never entered into our collective considerations. The twenties had taken care of that! Had we not overbuilt all our utilities—not only our water systems, but the electric utilities which furnish them power? Our regulatory bodies told us so, and the experiences of the past decade seemed to prove the truth of what we were told. But how different it is today! Most of the water utilities which serve war industry towns find their plants pretty well pushed to capacity and the power companies are asking them to curtail the use of power as much as possible.

A year or two ago we sought out our sources of waste primarily in order to cut down our bills to the power and chemical companies. Today we hunt them in order to relieve the load on our system and to help conserve essential power and chemicals for the war effort.

Yesterday we let those stray bits of iron and steel clutter up our yards and storage sheds. Their cash value was not considered commensurate with the effort necessary to get them to the scrap dealer. Today we collect them as a patriotic duty. For the same reason we should prevent the waste of every possible gallon of water. Perhaps our plants can stand the strain of not doing so, but today there is need elsewhere for every kilowatt of power and every ounce of chemicals.

It is against this background that the following remarks are made.

Losses Through Leakage

The most dangerous saboteur of our systems is, of course, the hidden leak. This leak may be large or small; it may be a blown joint or a broken main, or perhaps a leaking or abandoned service line. In the aggregate the loss is often quite astonishing. Few persons realize the large amount of water which will escape through a relatively small hole. For instance, a hole in a main into which one can barely squeeze the end of his little finger will, under a pressure of 65 psi., discharge more than 80,000 gpd.

Plumbing leaks can be eliminated if hard-boiled methods are used, but the underground leak which gives no surface indication of its existence requires a real campaign for its location and correction. Too often the existence of such leaks is doubted for no

A paper presented on October 20, 1942, at the Kentucky-Tennessee Section Meeting, Paducah, Ky., by Homer E. Beckwith, Dist. Mgr., The Pitometer Co., Pittsburgh.

other reason than they cannot be seen from the surface. But they can and do exist. The company with which the author is identified has been making surveys for the detection and location of these leaks for the past forty years and in that time has developed ample proof that this is so. One leak wasting more than 2 mgd. has been found under pavement which gave no surface indication of its existence; and several other leaks approaching that size have been located.

A few years ago a survey was made on a small plant having a total of 8 mi. of mains and supplying a population of 2300. A total of 57 blown joints and 6 miscellaneous leaks, which wasted over two-thirds of the water entering the system, were located. This is probably the largest average number of leaks per mile of main the writer has ever encountered, although another survey disclosed 27 blown joints on 26 mi. of mains leaking about 60 per cent of the total water pumped into the system. These are, of course, unusual cases; but it is interesting to note that in each instance it took several years to convince the officials that any appreciable leakage could exist. Moreover, they clearly show that very abnormal losses *are* possible.

Power Losses

It is not the purpose of this paper, however, to discuss leakage as such, but only in connection with its waste of power. It is true that most of the systems, where high percentages of leakage have been found, are supplied by gravity and the cost of pumping does not enter the picture, but even on plants where pumping is required losses often run quite high.

For instance, in Pittsburgh a reduction of some 30 mgd. has been effected (*1*). In Philadelphia, with 40 per cent of that city covered by a waste survey, about 13 mgd. has been saved (*2*). Neither of these cities uses electric power exclusively for pumping, but it is possible to see what would have been the approximate waste of power had electricity been used. A large pumping unit having a wire-to-water efficiency of about 85 per cent would pump some 1175 gal. against a head of 100 psi. for each kilowatthour consumed. This means that 25,500 kwhr. would have been required to pump the 30 mgd. of water which ran to waste every day in Pittsburgh. Against 120 psi., approximately 990 gal. would be pumped for each kwhr. consumed. Consequently about 13,000 kwhr. would be required to pump the 13 mgd. so far discovered to be leaking away each day in Philadelphia. It can thus readily be seen that very considerable generating capacity would be required to pump the wasted water-generating capacity which, under present conditions, is needed for other purposes.

In plants where the pumping is into a reservoir against a constant head, the saving in power resulting from a "Pitometer Water Waste Survey" is in direct relation to the amount of water saved—if the pumpage is reduced 10 per cent, the power consumption is reduced 10 per cent, etc. This is not true, however, where the pumps discharge into a closed system. Under these circumstances, the reduction is very problematical, unless smaller pumps are available to pump efficiently the reduced amount of water.

On the other hand, there are many systems which are normally fed by gravity supplies, but which, in emergency, have recourse to standby pumped supplies. These, in particular,

play havoc with the power demand under present conditions, as the demand is not constant and is only partially provided for.

The principles involved are simple. The depletion rate of a reservoir into which water is feeding is not the rate at which water is being taken out, but the difference between the input and the output. For instance, if water is being taken out at a rate of 850,000 gpd., there will be no drawdown until the flow into the reservoir, adjusted for reservoir losses, drops below 850,000 gpd. If it be assumed that the consumption is reduced to 600,000 gpd. by the elimination of leaks, then there will be no drawdown until the stream flow has dropped below 600,000 gpd. If the leaks had not been repaired, however, there would have been a drawdown of 250,000 gpd. If the stream flow were to drop further to 400,000 gpd., the drawdown after the repair of the leaks would be 200,000 gpd. as compared with 450,000 gpd. without the repair of the leaks.

It can, therefore, be seen that the existence of waste in a gravity plant has great leverage to deplete storage. Since emergency pumping is resorted to only when this storage gets dangerously low, the demands upon the power company are intermittent and most unprofitable in that they require standby generating capacity which is used only a few weeks of the year, if at all.

The inverse of the above procedure can also play havoc with a stored supply. The addition of legitimate use to a system which has always apparently had a large reserve supply has the same leverage to deplete that supply as does the waste mentioned above. Many water plants have recently discovered this. When a reservoir has never been "very low," even in the dryest weather, it seems that the addition of a defense plant to the system could not hurt. But it sometimes turns out that it does hurt, so that resort must be made to emergency pumping. An addition of 10 or 15 per cent to the use of water may double or treble the use of power for pumping, creating excessive demands upon the power company. If, however, this increased demand can be offset by the elimination of waste, the plant is in as good shape as before, or even in better shape, if the waste eliminated exceeds the additional demand.

An illustration of the above leverage principle is found in the instance of the small town of 2300 population previously mentioned. Normally, this village was supplied exclusively by gravity, but the combination of leaks and drought completely exhausted the stored supply so that only about 40 per cent of the consumption was secured by gravity, 60 per cent being pumped. Every bit of the water so pumped ran to waste, as the total leakage exceeded the pumpage. After the leaks had been repaired, it was possible to suspend pumping, and as far as is known, pumping has not been resorted to since. Leaks were responsible for all the power used. At that time, there was plenty of excess generating capacity, but that is not true today. What was an expensive luxury then has become almost criminal waste now.

The author is interested in a survey at present being made for a city whose normal use of water is approximately 20 mgd. About half of this water is supplied by gravity and half by pumping. The survey is about 80 per cent completed, and, so far, slightly over 3 mgd. leakage has been located and repaired. This is about 15 per cent of

the consumption, but about *30 per cent* of the *pumpage*.

Computation of Power Loss

Each operator can translate the amount of water waste into power waste by the following simple computation. It requires 3.14 kwhr. to pump 1 mil.gal. of water against 1 ft. of head at 100 per cent efficiency. From this we can find the power consumption for any efficiency or head, as all factors are in direct proportion. For instance, at 70 per cent wire-to-water efficiency and a 200-ft. head, the computation would be:

$$\frac{3.14\ (\text{constant}) \times 200\ (\text{head in ft.})}{70\%\ (\text{efficiency})} = 898 \text{ kwhr. per mil.gal.}$$

All that has previously been written here concerns the increased consumption of power due to leakage, but there is another serious source of wasted power. This results from the use of obsolete or inefficient pumps. The author has published several articles on this subject, together with the outline of a simple method for testing electrically driven centrifugal pumps for efficiency. These articles are available in one form or another and will not be repeated here; but there should be mentioned a few of the conditions which inspired their writing.

The old displacement type of steam pump was a very adaptable piece of machinery. Variations in the head or pumping rate made little difference in the efficiency of operation, but this is not true of the centrifugal pump. Alterations in head, speed or pumping rate very greatly effect its efficiency. Unfortunately, a full realization of the limitations of this type of pump has not always accompanied its installation. Too many operators remember the elasticity of the old steam units and expect similar elasticity from centrifugal pumps. But take it from me—"it just aint so." Such expedients as throttling the discharge valve to control the pumping rate are very wasteful of power. So is pumping at heads greatly under or over the design head. It will pay to inspect the performance curve of the pump or the design conditions as given on the nameplate, to be sure that it is operating under the conditions for which it was designed. Changes made at nominal cost have been known to cut power consumption by as much as 25 per cent.

If there is any particular text for this disseration, it is this—"Operate Efficiently." Stop your leaks. Check your pumps. Leaks and inefficiency are luxuries we can no longer afford. The power that is not burned to pump water to drain away uselessly may be used elsewhere to great advantage. Above all, remember that, at this particular time, it is not the operational cost of generating wasted power that counts the most, but the time, money and materials that would be required to build the plant to generate that power. So again—"Waste not, that others may not want."

References

1. Beckwith, Homer E. Water Waste Prevention and Correction in Pittsburgh. Jour. A.W.W.A., **34**:1523 (1942).
2. McLaughlin, Martin J. A New Philadelphia Story. W.W. & Sew., **89**:245 (1942).
3. Beckwith, Homer E. A Simple Method of Testing Centrifugal Pumps. Jour. A.W.W.A., **31**:2098 (1939).
4. ———. Some Notes on Electrically Driven Centrifugal Pumps. Jour. A.W.W.A., **23**:1120 (1931).
5. ———. Some Unusual Conditions Discovered Through Pitometer Water Waste Surveys. Jour. A.W.W.A., **21**:222 (1929).

Preservation of Phenol Content in Polluted River Water Samples Previous to Analysis

By M. B. Ettinger, Stuart Schott and C. C. Ruchhoft

BECAUSE of the tremendous effect phenolic pollution in raw water supply has upon otherwise satisfactory water purification processes, the determination of phenol in surface waters and plant effluents is a matter of importance to water plant operators and authorities concerned with stream sanitation. The determination of phenol by either of the methods described by *Standard Methods* (1) does not lend itself readily to field work. Accordingly, samples for phenol determination are likely to be "preserved" and transported to a suitable laboratory. The method of preservation of prescribed by *Standard Methods* is the addition of 1.5 ml. of $N/1$ NaOH per liter, after Baylis (2).

Phenol in moderate concentration can be broken down by micro-organisms so readily that phenolic wastes are successfully treated by trickling filters (3). The range of conditions under which biochemical transformations can be carried on is truly tremendous, apparent biochemical activity being reported at pH values ranging from low of 2 (4) to high of 13 (5).

A knowledge of the above facts gives rise to doubt as to the effectiveness of the preservation of phenol samples prescribed by *Standard Methods,* and suggests the desirability of an investigation of methods of preservation. Accordingly, when the opportunity presented itself, in the form of the Mahoning River Survey, including phenol studies, a study of several methods of preserving the phenol content of polluted river water was undertaken as the conduct of the regular survey work permitted. Samples being studied were stored in glass-stoppered bottles. Results are given in Table 1.

The pH data given in the table are somewhat fragmentary because of the limited facilities available. Phenol determinations were made by the Gibbs method, as outlined in *Standard Methods.* pH adjustments were made, when necessary, just prior to distillation, using phosphoric acid or sodium hydroxide.

The data in Table 1 indicate that the use of 1.5 ml. of $N/1$ NaOH per liter for preservation, as prescribed by *Standard Methods,* is most unsatisfactory in samples of sewage-polluted river water. Unpreserved samples lost their phenol content even more rapidly. Preservation at low pH (phosphoric acid) was the most effective of the first preservations studied, being slightly better than preservation at high pH with generous doses of sodium hydro-

A contribution by M. B. Ettinger, Asst. San. Chemist; Stuart Schott, Asst. Chemist; and C. C. Ruchhoft, Prin. Chemist; U.S. Public Health Service, Stream Pollution Investigations, Cincinnati, Ohio.

TABLE 1

Effect of Storage at Laboratory Temperature Upon the Phenol Content of Mahoning River Samples

Date 1940	Days Stored	Initial Phenol Content, ppb.	pH After Adjustment*				Final Phenol Content, ppb.*				Percentage Phenol Recovered*			
			A	B	C	D	A	B	C	D	A	B	C	D
11–18	2	640	—	8.4–9.0			10	250			1.5	39.1		
11–18	5	640	—	8.4–9.0			0	0			0	0		
11–27	1	225	6.0	8.4–9.0			25	120			11.1	53.3		
11–27	5	225		8.4–9.0			0	5			0	2.2		
12–16	3	290	6.0	8.4–9.0	1.9	10.2	5	5	240	240	1.7	1.7	82.8	82.8
12–9	3	200	6.4	8.4–9.0	1.9	10.2	0	100	180	140	0	50	90.0	70.0
12–4	3	375	—	—	2.0	10.2	0	0	300	220	0	0	80.0	58.6
12–29	4	830	6.6	7.2	1.9	10.2	5	10	700	600	0.6	12.0	84.3	72.3

* A—Water stored as collected; B—Preserved according to *Standard Methods* when collected; C—Preserved by addition of 20 ml. of 10-per cent phosphoric acid per liter; D—Preserved by addition of 4.3 ml. of 12*N* sodium hydroxide per liter.

oxide. It must be pointed out, however, that neither of these procedures was completely effective.

One experiment was conducted on the effect of low temperature storage on the phenol content of a sample. These data are given in Table 2. It will be noted that storage at 2°C. greatly retarded the rate of phenol decrease as compared to that shown by unpreserved samples in Table 1. These data, based on a single experiment, are too meager to justify definite conclusions other than that low temperatures will retard the rate of phenol decrease in a sample.

TABLE 2

Phenol Content of a Mahoning River Sample During Storage at 2° C., Variation ±1°

Data on Sample (0 days): pH, 6.6; Fe, 15 ppm. Turbidity, 65 ppm.

Days Stored	Phenol Content
	ppb.
0	650
4	550
11	45
21	8

In another series of experiments in the U.S.P.H.S. Stream Pollution Investigations' Cincinnati laboratory, the effectiveness of several other chemical reagents in preserving phenol samples was studied. The phenol samples were prepared by adding the desired quantities of a standard phenol solution to standard phosphate-buffered dilution water. Immediately after preparation, the phenol-containing water was seeded with sewage and divided into a number of portions, to some of which the chemicals to be tried were added. All samples were stored at room temperature and phenol determinations were made at intervals as before. The results obtained have been assembled in Table 3. These data show that the four reagents tried were more effective in preserving the initial

TABLE 3

Results of Preservation Experiments on Sewage-Seeded Phenol Samples in Dilution Water With Various Reagents for Inhibiting Biochemical Breakdown

Expt. No.	Sewage, ml./l.	Time of Storage, days	Phenol Found (ppb.) When Initial Sample Was Treated as Indicated, Before Storage						
			Control (Nothing Added)	Standard Procedure	Phosphoric Acid*	Sulfamic Acid†	Furoic Acid‡	Stannous Chloride§	Copper Sulfate¶
1	5	0	325		275	287	303	275	
		1	0		313	313	288	313	
		2	0		300	268	308	300	
		3	0		100	238	300	—	
		6	0		0	50	310	300	
2	10	0	288	300	305	290	310	278	300
		2	0	325	300	288	313	325	325
		3	0	263	0	313	238	263	250
		5	0	0	0	70	278	300	300
3	10	0		50	50		50	50	50
		2		10	50		45	45	50
		4		0	45		50	45	50
		7		0	20		45	50	50

* Preserved by addition of 20 ml. of 10 per cent phosphoric acid (85 per cent) per liter.
† Preserved by addition of 1 g. of technical sulfamic acid per liter.
‡ Preserved by addition of 1 g. of furoic acid (Eastman) per liter.
§ Preserved by addition of 2.5 g. of stannous chloride per liter.
¶ Preserved by addition of 3 ml. of 10 per cent copper sulfate solution per liter.

phenol content than any tried previously. Of these four, sulfamic acid, though better than phosphoric acid, was the poorest preservative, while furoic acid, stannous chloride and copper sulfate were apparently all equally good and much superior to the others. Of these, copper sulfate would seem to be the preferable reagent because it is cheap, easily obtainable, simple to use and very effective in arresting biochemical activity, thereby preserving phenol.

It has recently been shown (6) that an inhibitory reagent which contains copper sulfate, sulfamic acid and acetic acid is more effective in stopping biochemical oxidation in activated sludge liquors than any of its single constituents. This reagent could not be used for phenol preservation because of the possibility of the distillation of the acetic acid with the phenol. On the basis of the above experiments, however, it was believed that, if prolonged preservation of phenol samples was required, a reagent containing equal quantities of sulfamic acid and copper sulfate might be more effective than copper sulfate alone.

At Youngstown, Ohio, several phenolic wastes of high alkalinity, resulting from caustic washes, were encountered. As copper is precipitated at high pH, copper sulfate preservative treatment in high alkalinity solutions of this type have not been studied sufficiently. The observations given in Table 4 were made to investigate phenolic preservation possibilities further. Sulfamic acid and copper sulfate did not exhibit any marked superiority

TABLE 4

Results of Preservation Tests on Phenols in River Water and River Water Seeded With Sewage

Expt. No.	Sewage, ml./l	Time of Storage, days	Phenol Found (ppb. After Storage Period Indicated) Control (A)	Copper Sulfate (B)	Sulfamic Acid (C)	Copper Sulfate Plus Sulfamic Acid (D)	pH of Liquor as Stored A	B	C	D
4	0	0	100	100	100	100				
		2	0	100	100	100				
		6	—	95	25	40				
5	0	0	50	50	50	50	7.5	6.4	2.1	2.1
		2	0	50	—	—				
		4	—	0	30	45				
		7	—	0	15	25				
6	5	0	600	600	—	—	7.5	6.3	2.2	2.1
		2	0	550	530	580				
		4	—	530	160	260				
		7	—	60	0	0				

over copper sulfate alone. It should be noted, however, that in these experiments, failure of copper sulfate after two days' storage in one instance and after four days in another were found.

Summary

On the basis of the experiments described, the following conclusions have been reached:

1. That 1.5 ml. per liter of $N/1$ NaOH is not a satisfactory preservative for phenol in river samples.

2. That, of the procedures studied for the preservation of phenol, treatment with copper sulfate is most effective and is preferable.

3. That phenol should preferably be determined in a sample shortly after collection. Where this is not possible, preservation with 3 ml. of 10-per cent copper sulfate solution per liter of sample, when the collection is made, is indicated. This practice should be accompanied by refrigeration of the sample while in storage or transit, and in no case should the time interval between collection and examination exceed two days.

References

1. *Standard Methods for the Examination of Water and Sewage.* Am. Public Health Assn. & Am. Water Works Assn., New York (8th ed., 1936).
2. Baylis, J. R. Procedure for Making Quantitative Phenol Determinations. W.W. & Sew., **79**: 341 (1932).
3. Harlow, I. F. Waste Problems of a Chemical Company. Ind. Eng. Chem., **31**: 1346 (1939).
4. Ruchhoft, C. C., Ettinger, M. B. & Walker, W. W. Biochemical Oxidation in Acid Water Containing Sewage. Ind. Eng. Chem., **32**: 1394 (1940).
5. Theriault, E. J. & McNamee, P. D. Sludge-Aeration Experiments. I. Rate of Disappearance of Oxygen in Sludge. Ind. Eng. Chem., **22**: 1330 (1930); Pub. Health Repts., **46**: 1301 (1931).
6. Ruchhoft, C. C. & Placak, O. R. Studies of Sewage Purification. XVI. Determination of Dissolved Oxygen in Sludge Sewage Mixtures. Public Health Repts., **57**: 1047 (1942); Sew. Wks. J., **14**: 638 (1942).

A Lazy Man's Water Works

By George L. Wood

THE writer was *more* or *less* honored by the instigators and perpetrators of the California program by being asked to take up a portion of the time of his fellow sufferers of the water works field. These perpetrators chose the subject "A Lazy Man's Water Works," whatever that means. Perhaps it means the author is about the laziest man who ever got as far away from home as Oakland in one day at 35 mph. It *aint* the gray in our hair that makes us look so old, its this water works business and speed. Of course, there are various kinds of water—hot water and cold water, soft water and hard water, and some salt water lying west of Frisco; there is also such a thing as Long Beach water and some people even go so far as to claim there is such a thing as fire water.

But when it comes to water, nature has favored the City of Bishop more than most places. We have *good* water with *fish* in it, and its *free*. We get our water from Bishop Creek, a sizable mountain stream which flows downhill and is fed by snow waters. The extreme fluctuations of the creek

A paper presented on October 30, 1942, at the California Section Meeting, Oakland, Calif., by George L. Wood, Supt., Water Dept., Bishop, Calif.

Author—Giving Birth to Another Brainchild

are minimized, to a large extent, by numerous lakes. The three largest of these lakes are used by the California Electric Power Co. as storage reservoirs for its power plants along the creek.

The average flow of the stream is approximately 80 cfs., although there are times during the spring and summer runoff when it reaches as much as 450 cfs. Numerous summer resorts, public camp grounds and private

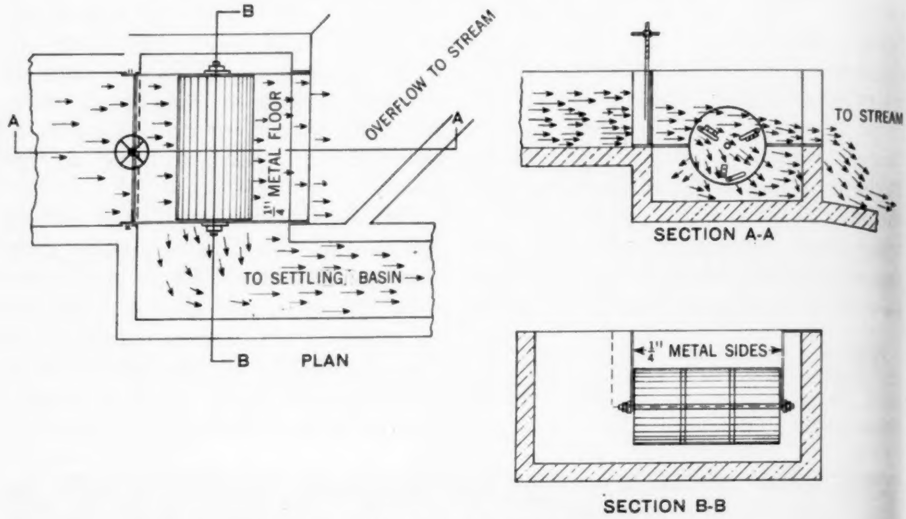

Fig. 1. Wood's Self-Cleaning Screen

cabins are located along the course of the stream. Normally the creek looks clear, but, during high water, it carries a very large amount of leaves, trash, sand and silt, so it is necessary to skim off the trash and settle the solids.

As our operating finances are small because we furnish free water (our operating and maintenance costs being a part of the $1 per $100 assessed valuation tax limitation), we have developed this Lazy Man's Water Works —*and it works.*

When I arrived on the scene in 1938, I found we had a storage reservoir of approximately 90,000-gal. capacity, or about three hours' supply. The only means of keeping the trash out was a 1 × 4 ft., $\frac{1}{4}$-in. mesh, stationary screen, which had to be cleaned by hand with a brush or broom. When the creek was riley—now listen fellows—some pretty smart people have told me "riley" water is spelled "roilly," but *our* water has been "riley," is now and probably will continue to be "riley." As I started to say, when the creek was riley, this screen would plug with trash within a few minutes, so that very little water or no water would get through. If the operator was not present practically all the time, the level of the water in the reservoir varied to a large extent. Then, when the screen was cleaned, the large flow of water would stir up any sediment that might be in the tank and, of course, this sediment would get into the main line and go to town.

Self-Cleaning Trash Screen

I surely had a pain in the head that first day and night, but by the next morning this headache had developed into an idea—and the self-operating,

self-cleaning trash screen (Figs. 1 and 2) and later brainstorms that developed into ideas, all go together to make this water works deserve its name. Thirty minutes of one man's time per day, counting a five-mile drive, usually suffices to take care of it. Now we make the trip mainly to check the chlorine and keep the records. We take water from the creek through an open concrete flume to the trash screen. The flume ahead of the screen has an overflow along one side to take care of sudden rises in the creek, which would tend to put too much water into the settling basin.

As you will note from the figure this is a revolving screen, the axis of which is at the level of the bottom of the flume. The screen rotates on the top in the same direction as the flow of the water.

Inside the screen there are three hinged paddles which, in the upper portion of the cycle, engage the stops on the hub ends of the screen. In the lower portion of the cycle, the paddles swing free and trail back with very little resistance.

You will also note that a certain amount of water goes straight through the screen and back to the creek. This water, by its action on the upper paddle, furnishes the motive power, and, as the water goes out through the screen, it cleans off and carries back to the creek all trash, fish, frogs, snakes or whatever coarse lumpy stuff may be in the water. This, of course, eventually goes to Los Angeles!

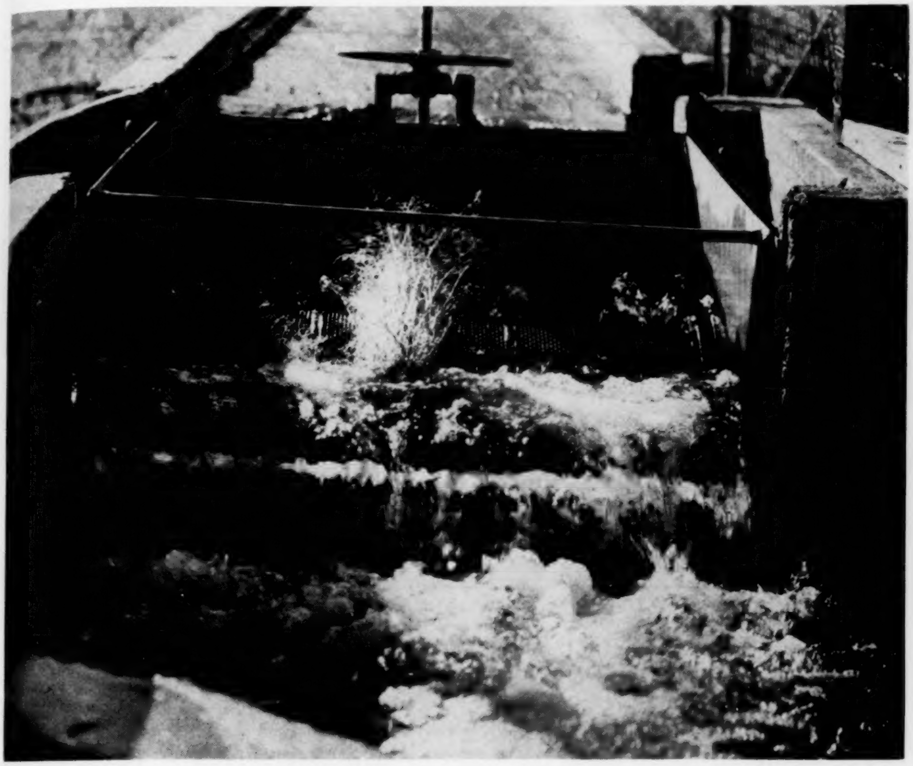

FIG. 2. Trash Screen at Work

The water that goes to the settling basin (Fig. 3) goes out through the bottom of the screen into the distribution flume, the water level of which is slightly below the water level in the upper flume.

Distribution Flume and Settling Basin

The velocity of the water is much less in the distribution flume; consequently there is a large amount of fine sand and water-soaked vegetation, which settles to the bottom. Whenever enough sediment accumulates to impair the efficiency of the flume, I just open the gate (Fig. 4) at the far end and sit down. In a few minutes it will clean itself and not affect the water in the settling basin. I always try to do this on a day when I am not *too* tired.

The flume runs the full width of the settling basin and the water is distributed as evenly as possible along the weir, the idea being to stop all currents as soon as possible and assist sedimentation.

The settling basin is 60 ft. wide and 250 ft. long on the bottom, with 2:1 slopes, and is 6 ft. deep. It is lined with 4 in. of concrete and is so arranged that it will drain to the flush gate when cleaning is necessary.

Skimmers

A certain amount of leaves and small débris is blown into the settling basin by the wind. This is taken care of by skimmers (Fig. 5). The skimmers in the corners are merely slight overflows to the creek, being 3-in. pipes, the ends of which are just enough below the water surface to create slight whirlpools, which suck the trash down and take it back to the creek. These skimmers do a good job of keeping the surface clean and, in hot weather, they tend to carry off the warmer surface water, so that our city supply is cooler.

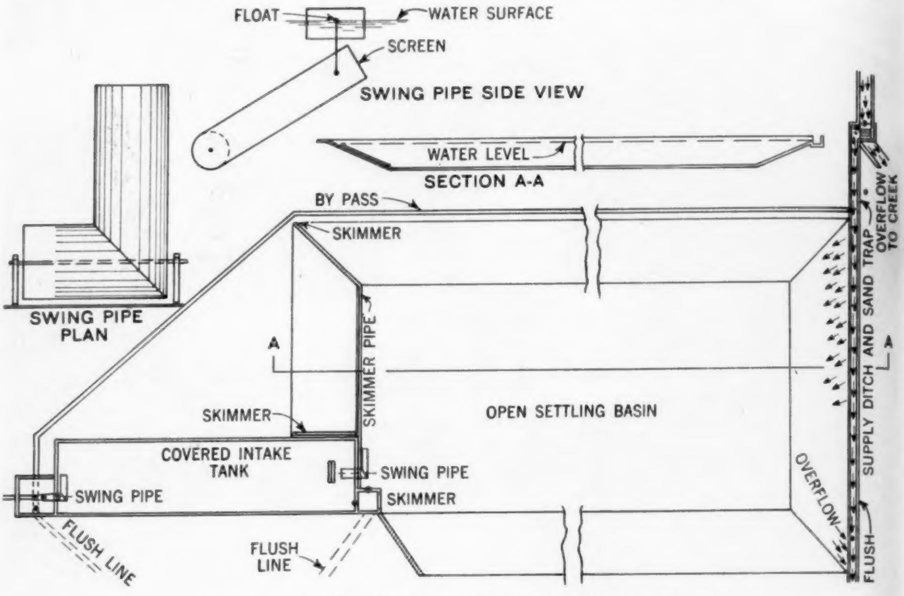

FIG. 3. Settling Basin and Detail of Swing Pipe

Swing Pipes

The gadget shown in Fig. 3 is what I call a "swing pipe." It swings up and down on its axis at its base and the elevation of the inlet end is controlled by the float. Its purpose is to take water from just far enough below the surface to get the cleanest water and still not have suction to draw in any surface trash that might be present. The swing pipe on the front of the covered intake tank takes top water from the settling basin and delivers it to the bottom of the intake tank.

The baffle tends to stop the current from the swing pipe, consequently increasing the efficiency of the intake tank. The second swing pipe is attached directly to the main going to the city, and, of course, its purpose is obvious. These pipes are fixed to swing up and down with the water level so that in the event of a shut-down at the headworks for repairs, or a temporary shortage of water in the creek (which has happened) we will be able to use all the water in the settling basin and, at the same time, always have the cleanest water possible.

The bypass line is used to supply the main line to the city when it is necessary to drain and clean the basin.

Fig. 4. Self-Cleaning Flume Gate

Chlorination

In spite of the precautions taken by the State Health Department, Forest Service, power company and other interested parties, the originally pure snow water is always contaminated by campers and other natural (?) causes, sometimes to a large degree.

We chlorinate the water in the main line just below the master meter with

a dry feed chlorinator of the vintage of 1929. Our average daily consumption of chlorine for the past year was $1\frac{1}{3}$ lb. and cost us about 13 cents per lb. The capacity of our settling basin and intake tank is approximately a million gallons which is about twenty-four hours' supply.

During the first year of operation of this plant we supplied an average of 1416 gpd. to each of approximately 500 services. Our daily per capita consumption averaged 350 gal. Of course our heaviest consumption is during the warm weather when the creek is at its worst, but, since we started operating our new plant, the consumers have not known *if* or *when* the creek was riley because of the efficiency of this Lazy Man's Water Works.

Fred W. Weber of Downey, Calif., was the contractor for the new intake and a considerable amount of main laying. Koebig & Koebig of Los Angeles were the engineers.

As an operator of a Lazy Man's Water Works, I am, at this stage of preparation of this paper, pretty tired, but I shall be glad to make the additional effort to answer any questions which will help my fellow water works men to follow any of my leisurely steps.

FIG. 5. Three-Inch Pipe Skimmer

Wartime Problems of the East Bay Municipal Utility District

By J. S. Longwell

WARTIME problems in connection with the operation of public water supply systems vary to a great extent, depending on the location of the community served and its relation to the war program. They also vary with the different types of production, transmission and distribution systems and the location of the new consumption load resulting from the present emergency.

On the east side of San Francisco Bay, water is supplied by the East Bay Municipal Utility District, a publicly owned corporation organized under the California Utility District Act of 1921. The District covers an area of some 190 sq.mi., including the nine cities from Richmond on the north to San Leandro on the south, together with a large adjacent unincorporated area including the town of Rodeo, five county water districts and other large rural residential developments. The population of the District is now estimated to be approximately 600,000. Oakland, the largest city, has a population of 330,000 and Berkeley, next largest, 95,000.

The entire East Bay is an important defense area, including Army and Navy bases, training centers, hospitals, ship-building plants and numerous large industrial plants engaged in war production. Water within the District is supplied almost entirely from District facilities, only a small amount being obtained from private wells and from three small reservoirs. Outside District boundaries, surplus water is furnished to Vallejo, to several Army and Navy institutions and to a number of large industries.

Water Supply Facilities

Pardee Reservoir on the Mokelumne River about 100 mi. northeast of Oakland is the principal source of water supply for the District. This reservoir has a capacity of 68 bil.gal. or 210,000 acre-ft. and the safe yield of the development is 200 mgd. Water is brought down across the San Joaquin Valley to the District by means of the Mokelumne Aqueduct, 93 mi. long, on which all diversion works, tunnels and similar permanent features were constructed with a capacity of 200 mgd. The steel pipe section, 82 mi. in length and principally 65 in. in diameter, however, has a capacity of 70 mgd. Additional lines are to be installed on the right of way, paralleling the present steel pipe, as

---

A paper presented on October 29, 1942, at the California Section Meeting, Oakland, Calif., by J. S. Longwell, Chief Engr. & Gen. Mgr., East Bay Municipal Utility District, Oakland, Calif.

required to meet the future needs of the District, with an ultimate capacity of 200 mgd.

Supplementing the Mokelumne supply, the District owns and operates four reservoirs in the hills in back of Oakland and the other District cities. These reservoirs have a combined capacity of 33 bil.gal. or 100,000 acre-ft. and serve as terminals for the Mokelumne supply, since water from the aqueduct may be delivered to any one of them. In addition they collect water from some 75 sq.mi. of tributary drainage area, the runoff from which produces a safe yield of approximately 21 mgd.

The District operates five filtration plants and all water supplied to the distribution system is filtered and treated regardless of whether it is delivered direct to the distribution system from the aqueduct or withdrawn from one or more of the four terminal reservoirs. All plants are of the rapid sand type and have a total nominal capacity of 75 mgd., but under normal conditions can operate at a 50-per cent overload, giving a capacity of about 113 mgd.

From the filtration plants the supply goes directly to the mains for distribution to all consumers. Some 1,800 mi. of pipe are now in service to provide this distribution. The major portion of the output is delivered by gravity, directly from the filter plants, but a large part of the residential area extends up the hills nearly to an elevation 1500 ft. All elevations above 250 ft. are supplied from higher reservoirs and tanks to which the supply is raised by pumping. Forty-six distribution pumping plants are in service boosting to the various higher zones in stages of approximately 200 ft.

Protective Measures

In the latter part of 1940, as it became evident that this country would have to undertake a definite program of war preparation, steps were taken by the District to provide for protection against possible sabotage and for necessary emergency operation and repairs in case of attack.

The distribution system was divided into some 34 protection zones and experienced employees were assigned to each zone. In the event of trouble due to sabotage or disaster of any nature, these employees are to report immediately to their zones, survey the water supply facilities therein, observe any damage done, make emergency repairs, if possible, and report conditions to headquarters.

Under the same general program, a number of other precautions were taken: (1) high chain link fences topped with barbed wire were installed around all important properties not previously so protected; (2) wherever possible exposed sections of large mains were covered; (3) special precautions were taken at manholes and similar structures; (4) many new gate valves were installed to permit isolation of damaged sections of the system; and (5) an ample supply of pipe, valves, hydrants and miscellaneous fittings was purchased and placed in stock for emergency use. In addition, the District co-operated closely with federal, state, county and city defense agencies and assisted in the development of plans for the protection of its facilities and the minimizing of possible interruption in the water supply for the area. As the various governmental agencies, operating under the general plan of the Office of Civilian Defense, organized their systems of air

raid wardens, communication centers, classes of instructions and related activities, District representatives met with them and took steps to fit its plans in with the general procedure. This was somewhat difficult at times due to the fact that the District's distribution system operates in two counties, nine cities and numerous unincorporated communities.

Due to the large number of agencies involved, it was not possible to participate fully in the program of each agency but, by full co-operation and explanation of just what the District required for best protection, a workable program was developed. Under this procedure the District has representatives at the four larger communication centers. These representatives report immediately to the communication centers upon the first alert signal. As reports come in to these centers affecting water supply facilities, the District representative is to telephone such reports to District headquarters, from which point repair crews and equipment are to be dispatched as required. In the numerous smaller communication centers, no District representative is present, but arrangements have been made to have all incidents affecting the District phoned to District headquarters, at which point the necessary action will be taken.

Travel of District emergency equipment during blackouts has been arranged by the issuance of permits by the Defense Co-ordinator of Alameda County. These permits are pasted on the windshields of the 60 vehicles to be used and are recognized by the various cities as well as by the other counties. All such equipment is provided with the special blackout lights. Employees assigned to emergency work are provided with special OCD armbands which permit access to all emergency operations.

As the defense program proceeded, special emergency equipment was purchased or manufactured by the District. This consisted of: portable gasoline-engine-driven pumping units to replace distribution pumping plants in the event that electric power is not available; a special portable gasoline-engine-driven electric generator to provide power up to 100 hp. for use at filter plants, pumping plants and other properties; portable chlorination outfits for disinfection of mains in emergencies; valve-operating equipment some driven by portable lighting sets and some by power take-off on repair trucks; and other items of a similar nature.

Guarding

In the fall of 1941, fingerprinting of all employees was undertaken and the records of all employees were checked through the FBI. All employees were photographed and badges were made up for all outside forces. This work was practically completed at the time war was declared and has been continued and expanded since that time. Special "No trespassing or loitering" signs were posted at all properties, a few guards were employed at some of the more important dams and plants and all plants were closed to visitors.

With the attack at Pearl Harbor, armed guards were employed and stationed on a 24-hr. basis at dams, at a number of vital points along the aqueduct and at filter plants, pumping plants and other important distribution structures. Approximately 90 guards were thus employed and were obtained at first from the regular op-

erating, maintenance and construction forces. Later, most of the regular employees were returned to their former positions and new employees were obtained for the guard positions. Arrangements were made with the various police departments and sheriff's offices for co-operation in emergencies and special District forces were made available to assist the guards if needed.

Guards were provided only for those structures and facilities that are most vital in furnishing a continuous supply of water or that are of such a type that an unduly long time would be required to make repairs. The number of guards at the various locations was governed by existing conditions, an attempt being made to give reasonable protection against sabotage. It was not physically possible to protect all points nor could adequate protection be provided against large-scale enemy operations.

No assistance in guard work has been obtained from either the state or federal government and the entire expense of guarding has been assumed by the District. Since December 7, 1941, this expense has averaged over $12,000 per month, or approximately $150,000 per year, a substantial item in the annual budget.

Watershed Fire Protection

In peacetime the District has a serious fire hazard on its watershed lands resulting from the long dry period from April to November. Under war conditions this hazard is greatly increased, since the use of incendiary bombs could easily result in a fire far beyond anything ever experienced in normal times. Fires on these watershed lands destroy the forest, brush and grass coverage so that, during the following rainy season, the soil is badly eroded. When this soil is carried down and deposited in the storage reservoirs, their life is greatly decreased. The District owns some 50,000 acres of these watershed lands and has for several years been conducting an erosion control program involving tree planting, construction of check and debris dams and improved agricultural and feeding practices. Any extensive fires are a serious setback to this program.

A further hazard exists from the fact that a large part of the terminal reservoir watershed lands is adjacent to and just over the hills from the East Bay cities. Fires on the watershed lands could spread to the residential developments, as they did in Berkeley in 1923, destroying many homes. This danger to the area has been fully recognized by the military authorities and, with their support, a co-operative program has been worked out between the state, various cities, counties, fire districts and the District. Additional equipment has been obtained, fire roads have been improved, water tanks have been erected at strategic points to furnish refills for the fire trucks and the personnel has been increased.

In this program the District operates one fire truck at Pardee Dam, co-operating with the State Department of Forestry which maintains fire fighting equipment throughout the foothill area. For the watersheds of the terminal reservoirs, the District operates two fire trucks on duty 24 hr. per day and one watch-tower, together with daily patrol of District lands. Additional equipment for the protection of private lands is provided by the state, by the various cities and by several fire

districts. A second fire watch-tower is operated by the City of Berkeley.

Under this program all equipment is available on both private and District lands and the fire problem is believed to be well under control.

Effect of Expansion of War Bases and Industries

Throughout the past year all existing Army and Navy bases have been expanded and many new ones have been constructed. Notable additions have been made to the ship-building and other industries. Along with this growth has come a large housing program, first involving structures of the more permanent type but gradually shifting to temporary houses, apartments and dormitories. In the past few months government-financed projects have practically all been of a temporary nature. Privately financed projects with "Title VI" homes still continue but on a reduced scale. At present over 6000 housing units of various types are under construction within the District and it estimated that this program will have to continue for some time in order to house the large number of defense workers moving in constantly to take their places in war industries.

To provide water for these bases, industries and housing projects, it has been necessary to expand the system. During the fiscal year ended June 30, 1942, 44 mi. of water mains were installed and from July 1 to October 15, 1942, an additional 19 mi. have been placed.

On the lines supplying the war bases and industries, comparatively few water services were required, as, in most cases, the new mains supply individual plants or bases. In one instance, $3\frac{1}{2}$ mi. of pipe were installed to serve one training center. The lines to serve housing projects are divided into two classes: (1) those to serve publicly financed projects developed by the Navy or by federal housing authorities; (2) those to serve privately financed projects. The former are served through one or two services installed at the project limits, the distributing mains within the project being placed and operated by the federal agencies. For the second group all mains leading to and within the project, as well as the services to individual units, are installed by the District under its standard regulations.

On October 1, 1942, there were 160,107 water services in active use, as compared with 153,541 on October 1, 1941, a gain of 7,566. In the previous year, 7,139 such services were installed. These gains, however, do not represent the real growth in number of consumers. At many of the housing projects one District service provides water for several hundred buildings and at one camp, to several thousand men.

With this expansion the use of water has shown a decided increase and that figure is a better measure of the additional demands on the system, resulting from the war effort, than the increase in number of services. Water consumption in the fiscal year ended June 30, 1942, averaged 53.3 mgd., 15 per cent above the previous year. During the first $3\frac{1}{2}$ mo. of the present fiscal year, consumption has been 17 per cent greater than for the same period of last year. This substantial increase has not resulted in any trouble so far as the supply available from the aqueduct or the terminal reservoirs or at the filter plants is concerned, since all such features have ample reserve ca-

pacity. It has, however, resulted in taxing the capacity of certain feeder lines in some sections and has brought out the need for additional reserve storage in others.

Employment

Perhaps the most troublesome problem resulting from existing war conditions has been the matter of retaining an adequate personnel for carrying on the business of development and distribution of the water supply. High wages in the war industries, particularly in ship-building, have caused many employees to leave District service, notwithstanding the fact that District operates under civil service, has a pension or retirement plan in effect and grants vacation leave and sick leave to all employees. Salaries and wages have been increased and overtime for all physical forces is paid at time-and-a-half rates. Since January 1, 1942, some 108 employees of the total of 850 at that time have left District service. It is difficult to retain a laborer at $140 per month when he can make more than twice that with contractors and at various industries by working six 10-hr. days with time-and-a-half pay for all time over 8 hr. per day and for the entire sixth day. District working hours are five 8-hr. days, or 40 hr. per week. Notwithstanding this inducement to leave, the large majority have been farsighted enough to see that, in the long run, they are much better off by staying.

At present the field forces seem about stabilized, as few are leaving to work in other industries. Serious difficulties are being experienced, however, in retaining competent women for office work. This has been brought about by high wages offered not only to women in industry but also for office workers, such as stenographers, comptometer and punch operators and similar classifications. A utility which must operate within a budget that cannot be unduly expanded is confronted with a serious situation in retaining a personnel of sufficient size to take care of operating routine.

In addition to the loss of employees to other industries, serious personnel losses are being sustained due to the entrance of male employees into the armed forces, through the draft or through enlistment. Thus far, twenty employees have gone into these services and as the war program is expanded it is likely that many more will go. All such employees are granted military leave and are assured employment upon their return to civilian life.

To replace these losses it is necessary to train new employees, both men and women, and it will probably be necessary in the future to employ women in such positions as meter readers, service men, collectors and like classifications which have always, in the past, been filled by male employees.

As the situation becomes more acute, consideration will have to be given to the reading of meters every two months instead of monthly, particularly in the outlying areas and possibly throughout the system. It has not become necessary for the District to take any such steps as yet, but they are being considered as a possibility.

In a number of cases it has been necessary to ask for draft deferment of certain employees. These requests have been confined to employees who cannot be replaced and who are essential to the proper operation of the system. Thus far, full co-operation has

been received from the various draft boards as they have realized the importance of maintaining the District's operating organization.

Civil Service

All publicly owned water supply organizations operating under civil service and located in defense areas are doubtless experiencing somewhat the same difficulties in maintaining eligible lists and in obtaining employees of the proper caliber for filling vacancies. A recent examination for junior clerks resulted in the establishment of an eligible list of 33. It was desired to make 17 appointments from this list, but, by the time 13 positions had been filled, the list was exhausted and this was within a few weeks after the examination had been given. This difficulty results from the fact that, by the time the examination papers are graded and the list is established, a great many have already obtained positions. Had the District been able to hire at the time the original application was filed, it could have filled its requirements. Now that the eligible list is exhausted, it will be necessary to hire employees under temporary appointment, which cannot exceed six months. Meanwhile, another examination must be given. This situation is true to a greater or lesser degree in most of the classifications.

Although great care is used in giving permanent employment after the probationary period, it will be very difficult to maintain the high standard desired for District employees. For this reason it is hoped that the Utility District Act may be amended at an early date to permit temporary employment for the duration without granting permanent civil service status. Otherwise, the efficiency of the organization may eventually suffer very severely.

Tire and Gas Rationing

Normally the District operates a fleet of approximately 250 cars and trucks in carrying on its many activities. With the rubber shortage and tire rationing, however, definite steps were taken to curtail the use of all automotive equipment in order to get the greatest possible benefit out of the existing stock of tires. In many cases, cars formerly assigned to individuals have been pooled and made available for groups; field inspections have been curtailed and the use of the mails and the telephone encouraged. Consideration has been given to the use of motorcycles and bicycles instead of cars. One bicycle has already been placed in service. All drivers have been requested to reduce their mileage by a definite percentage and careful checks are made monthly to determine what has been accomplished. Substantial reductions have already been made and further curtailment will follow. Gas rationing [not in effect at the time of writing] will probably further decrease the use of this equipment.

Summary

Although the District has been confronted with many problems and difficulties due to existing war conditions, some of which have been outlined in the previous paragraphs, there has been no curtailment of service to the consumers and an ample water supply has been available at all points throughout the system. Delays in obtaining priorities and materials have caused inconvenience to some, due to the longer time required to make the water avail-

able, but these conditions have been understood and have been accepted as something that must accompany a full-scale war program.

All of these operating difficulties, together with the higher costs of labor and materials, have naturally resulted in substantially increased construction, maintenance and operation costs. Thus far, however, the increase in sales has been sufficient to offset these higher costs and it is hoped that it may be possible to build up some reserve to take care of replacements which are now being deferred through lack of necessary materials.

It is becoming increasingly difficult to operate and maintain the usual standards, and as the personnel is further depleted and materials are further curtailed this situation will doubtless continue to grow more serious. The District, however, along with all other water supply organizations, will continue to do its part in co-operating fully in the war effort and in keeping an adequate water supply available at all times.

Safety in Water Plants

By V. W. Buys

THE word "hazard" has several definitions, two of which are pertinent to this discussion. First of the definitions listed by *Webster* is: "An old dice game of which *craps* is a simplified form." A little analysis will indicate how practical an approach that is to the subject of safety. The dice game (when honest) is certainly a game of chance—there is always a winning and a losing side. In many water plants, the safety program is, likewise, often a matter of chance—for every accident that happens but does not cause personal injury or property damage, several do have costly results.

The second and more conventional definition of "hazard" is: "A risk, danger or peril." It is, of course, this meaning which the author employs in this discussion.

In the safe operation of any water plant, the superintendent is faced with three classes of hazards: (1) physical injury; (2) infection; and (3) the gas hazard, causing asphyxiation and/or explosion. It will be well to consider each of these classes separately.

Physical Injury Hazard

The physical injury hazards consist of those which can result in such injuries as burns (caused by fire, electricity or chemicals), cuts and abrasions, eye and head bruises, etc. In eliminating these hazards, much depends on the plant layout, good plant housekeeping and mechanical safeguards. The superintendent can correct such hazards to a large extent by an inspection of the plant. The conditions that cause accidents are tangible and can be seen. In inspecting a plant for this class of hazard, one should be on the lookout for such things as adequate walkways, proper railings and handholds, proper storage and piling of materials, sufficient illumination, elimination of slippery conditions, proper guards on moving equipment and proper insulation around switchboards and other electrical equipment. Many safety reforms of this nature can be built into the plant. It is realized, of course, that this is not always possible in all cases, but in the exceptions there can be provided personal safety devices, such as safety belts for men working over tanks and pools, lineman's gloves for men working around electrical equipment and goggles for those handling chemicals or doing maintenance work that requires welding, cutting or chipping. In the more modern plants many of these safety features were provided for in the design. The older plants can be brought up to date in this respect. A superin-

A paper presented on September 25, 1942, at the Minnesota Section Meeting, St. Paul, Minn., by V. W. Buys, Mine Safety Appliances Co., Minneapolis, Minn.

tendent with an honest desire for a safe plant, an analytical mind and a keen eye can do a good job of keeping accidents to an absolute minimum.

Infection Hazard

The second classification, infection, covers an intangible element. It is a hazard that exists in some operations due to the nature of the work. Infections start when a germ enters the body through a break in the protecting tissue. This is always true. A germ on unbroken tissue will die, causing no harm. If it lodges in a cut, sore or burned area, it will take hold, enter the bloodstream and exert its effect. If it enters the mouth, it may find an opening in a mouth sore or even a break in the tissue along the digestive tract, with the same result. These germs are in the air one breathes and can enter through the respiratory system as well. To combat this hazard, body cleanliness is the first step. Proper and convenient toilet facilities should be provided. The next line of defense should be accessible first aid equipment. Every wound, regardless of how small, should be given first aid. Kits of the unit type provide a form of first aid that is safe, simple and convenient for the layman to use. Infection invariably starts in that small scratch that is thought too insignificant to require first aid. There is this to remember—it isn't the scratch that counts, it's the germ that is present that causes the trouble. Many plants use dust respirators to prevent the inhalation of germ-laden and nuisance dusts.

Gas Hazard

The third classification, that of gas, causing asphyxiation and explosion, is the hazard which cannot be stressed too much. It is the hazard that cannot be seen on inspection. It is the hazard that lies dormant for years—that gives one the dangerous attitude that "it can't happen here." When the gas hazard strikes it is the most costly of all. To cope with it, it is necessary for the plant operator to exercise vision—vision to analyze this hazard from the standpoint of possibility and not probability. It is not very probable that gas will accumulate in a manhole or well and blow up. No! But it is *possible* and it does happen. In analyzing the approach to this problem, it will be well to look first at the various gases with which the superintendent must deal.

Classification of Dangerous Gases and Their Principal Sources

Poisonous Gases

Ammonia—dangerous at 0.25 per cent; explosive from 16 to 25 per cent

Carbon Monoxide—found in manufactured fuel gas, products of combustion and in exhaust gas from motors; dangerous at 0.04 per cent; explosive from 12.5 to 75 per cent

Chlorine—used in water purification and chemical treatment; dangerous at 0.004 per cent

Gasoline—found in motor vehicles and storage tanks; fatal at approximately 2.5 per cent; explosive from 1.3 to 6 per cent.

Suffocating Gases

Carbon dioxide—products of combustion/sewer gas; not dangerous in itself, but usually accompanied by deficiency of oxygen, which is fatal

Natural or Methane Gas—explosive from 4.8 to 15 per cent.

Some of these gases are encountered in every plant; others are generated in their processes; and still others, such

as chlorine, are used in chemical treatment. They all must be reckoned with.

Protection Against Gases

In protecting against these gas hazards, two things must be done. Both are equally important. One without the other is almost an admission of lack of reasonable care and conscientious effort, comparable, perhaps, to supplying an aviator with a parachute, but no suitable harness with which to attach it.

The first step is the proper detection of the hazard and the second is the proper protection against the hazard. It should be remembered that *gas plays no favorites*. When the concentration reaches a certain point, it overcomes; at another point, it kills; and at a third concentration, it is explosive. A person who has breathed a certain gas with no harm to himself gets a false sense of immunity or the idea that "this gas business is the bunk." But when that certain concentration is inhaled, the results are predictable for all individuals.

Detection of gas today is a simple matter. Modern instruments make this work quick and easy and give direct readings.

The second consideration is mask equipment to protect men who have to work in a gaseous atmosphere. For this measure, three types of masks are in common use: (1) the hose mask; (2) the canister mask; and (3) the oxygen breathing apparatus.

In conclusion, the writer would like to impress upon the men responsible for the safe operation of water plants that many accidents can be prevented and others can be minimized if there exists in their minds an honest desire for a safe plant. Many accidents have occurred, so that it is possible to benefit from others' past experiences.

Why wait to have this experience at your plant? Learning by experience is costly and will teach you nothing that cannot be learned from the printed page. A few dollars spent on adequate safety equipment will pay dividends all around. You will be satisfied in knowing that hazards have been anticipated and that proper protection is available. Your operators will know that safety is a part of your program *as a fact*, rather than merely a slogan to post, talk about and forget.

There is nothing mysterious about accidents. They are caused by neglect or carelessness on the part of some person or persons. The person responsible can do his part in engineering and operating the plant so that accidents will not be caused due to his neglect or carelessness. If accidents happen due to neglect or carelessness of someone else, he can provide the means for correcting such a situation.

Report of the Committee on Water Works Practice

HEREWITH is a report presented to the Board of Directors of the American Water Works Association at its annual meeting on January 18 and 19. A record of the more important decisions taken by the Board along the lines indicated in this report appears in the Appendix of this report (p. 328).

This report is a summary of the technical activities of the A.W.W.A., as guided by the Committee on Water Works Practice. The report also covers activities of the committees of other associations, where the A.W.W.A. has an appointed representative.

There has been no change in the personnel of the Water Works Practice Committee during 1942 (*see* 1942 Membership Directory, p. 163, for committee personnel).

The Board of Directors, at its Chicago meeting, took cognizance of the activities of the War Production Board which affect specifications and materials. It adopted the following wartime policy:

A special subcommittee consisting of the Chairman and Vice-Chairman of the Water Works Practice Committee and the Secretary shall be authorized to consider revisions, or modifications, of existing specifications, or preparation of new specifications to meet conditions set up by the war emergency.

When the content of the text has been agreed upon by the three members of the subcommittee, the material shall be submitted by letter-ballot to the Water Works Practice Committee and to the Board of Directors.

A period of two weeks shall be allowed for the filing of objections to, or acceptance of, the specifications. If a consensus of opinion develops, the material shall be issued either as: (1) tentative A.W.W.A. specifications; (2) emergency A.W.W.A. specifications; or (3) an emergency wartime rider to existing specifications.

Water Works Practice Committees

1. *Deep Wells and Deep Well Pumps:* This committee has suspended its work for the duration of the war.

2. *Manual of Water Quality and Treatment:* The sales of this text continue. No revision is in progress. The Publication Committee report (p. 329) records the status of sales.

3. *History of Water Purification:* Under date of January 1, 1943, M. N. Baker reports as follows:

"The History of Water Purification is nearly ready for the printer. In styling the book for the printer, I am following the general typographical scheme of the A.W.W.A. *Manual of Water Quality and Treatment.* [The complete text has since been received at the A.W.W.A. office. Negotiations with the printer are now in progress.]

Provision has been made in the budget for printing this material. The

completion of this project will make available an unparalleled record of water works advancement.

4. *Safe Handling of Water Works Chemicals:* No work is in progress. The report on handling activated carbon has not been published because of issues raised by committee members since the report was filed.

5. *Steel Plate Pipe:* A revision of Specifications 7A.4 has been approved by the Board, but publication has been withheld pending discussion at the current meeting. At the meeting of the Board in June, approval was also given for the publication of the Emergency Specifications as they might be developed by the War Production Board. This work has not been completed.

The title of Specifications 7A.6 was authorized to be changed to: "Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes up to but Not Including 30 Inches." This title change removes the numerical dimension of "4½ inches."

6. *Laying Cast-Iron Pipe:* No revision is in progress.

7. *Valves, Sluice Gates and Fire Hydrants*

7.1 *Valves:* The Association's committee has no work in progress. The WPB has emergency specifications in preparation which will affect the A.W.W.A. document for the duration.*

7.2 *Sluice Gates:* No work is in progress. The specifications remain tentative and should remain so for the duration.

7.3 *Hydrants:* No work is in progres. WPB modifications (Limitation Order L-39 †) affect the product for the duration, in that the use of copper is restricted in the manufacture of hydrant fittings to valve seat discs, guides, operating valve stems, stuffing boxes, nuts, bolts, bushings, rivets and retainer rings.

The A.W.W.A. committee has been unable to accept the suggestion made by the N.F.P.A. committee, covering torque test for hydrant stems. While the A.W.W.A. committee is willing to define an allowable breaking test for stems, it is unable to accept the high torque figure proposed by the N.F.P.A.

A. L. Brown, Chairman of the N.F.P.A. Committee on Hydrants, Valves and Pipe Fittings, in his 1942 report to that organization (*N.F.P.A. Quarterly,* vol. 36, no. 1, part 2), stated:

"There were six minor items in which the N.F.P.A. and the A.W.W.A. specifications differed, but those were straightened out, with the exception of one, which had to do with the wording of a section of the A.W.W.A. specifications relating to the hydrant stem. The A.W.W.A. referred this to its Water Works Practice Committee and it circularized manufacturers in order to arrive at some satisfactory method of testing the strength of stems. Due to war conditions, the manufacturers have not been able to provide this information, so the specifications still stand about where they were last year. After what you heard . . . about the use of substitute materials, it is unlikely that these specifications will be followed exactly during the war period."

8. *Location Records and Maintenance of Mains and Services:* No work is in progress. The U.S. Army has adopted parts of this committee's report for use in all Army cantonments, etc. The information is contained in

* Order L-252 was issued on January 23, 1943. It is printed in full on page 405.

† See p. 414.

the Engineer Corps' *Repair and Utilities Manual.*

9. *Steel Standpipes and Elevated Tanks:* Minor revisions of the text have been approved and published in the JOURNAL (December 1942). These specifications were widely used on war-related construction until the limitations of WPB Order M-126 made this difficult.

10. *Pipeline Coefficients:* No progress is reported.

11. *Distribution System Safety:* The report of the committee has been approved and published in the JOURNAL (June 1942) as a "Tentative Manual of Safe Water Distribution." The committee is at present inactive. The U.S.P.H.S. Manual related to the 1942 Drinking Water Standards, published in the JOURNAL (February 1943), contains much material which relates to distribution systems. The documents are not in accord and certain issues will need to be discussed in the technical sessions during the 1943 Conference.

12. *Cross-Connections:* The Committee has had no work in progress since the completion of its report which was published in the January 1942 JOURNAL.

13. *Fire Prevention and Protection:* No work is in progress.

14. *Meters:* The Tentative Specifications for Cold Water Meters, adopted in 1941, have been affected by the restrictions imposed by the WPB. Emergency Alternate Provisions have been approved and published in the JOURNAL (December 1942).

15. *Service Line Materials:* No water works material has been so seriously affected as service piping. All types are made of critical materials. At present the use of copper tubing or pipe is forbidden by WPB Order M-9-c-4. Plastics such as "Saran" and "Tenite" are entering the field. The compilation of specifications made by the A.W.W.A. committee has not been published. The data contained therein are derived from standard specifications issued by other organizations and are separately available to those who use them.

16. *Recommended Design for Valve Boxes and Covers, Curb Stop Boxes and Covers and Meter Boxes and Covers:* This committee was organized under the chairmanship of Frank C. Amsbary Jr. A review of manufacturers' practices indicates that there is a wide field for the activities of a correlating committee. The present plan of the committee's chairman is to submit recommended minimum design standards only. A preliminary report of the activities of the committee is anticipated at the time of the 1943 Conference.

17. *Recommended Standards for Threads for Underground Service Line Fittings:* William W. Brush has undertaken the chairmanship of this committee, but reports no progress to date due to inability of its personnel to devote time to the work.

Water Purification Division Committees

18. *Zeolites:* The report of this committee is in the form of a "Manual of Zeolite Test Procedures," which the Executive Committee of the Water Purification Division has approved for publication. Its magnitude is such that it will not be sent to the Water Works Practice Committee nor to the Board of Directors until it has been set in type for the JOURNAL. The manual will be published in the JOURNAL as soon as approval has been received.

19. *Permissible Loadings and Capacities of Water Treatment Plants:* This committee is putting its work forward as rapidly as wartime demands upon its personnel permit.

20. *Water Conditioning Methods to Inhibit Corrosion:* This committee developed a report on "The Value of Sodium Hexametaphosphate in the Control of Difficulties Due to Corrosion in Water Systems," which was published in the December 1943 JOURNAL. Since the report was completed, the Chairman has entered military service. The Water Purification Division officers have decided to suspend the work of the committee until the end of the war.

21. *Specifications for Filtering Material:* This committee, under Chairman Paul Hansen, has filed its report. It was discussed by the Division at the Chicago Conference. While the officers of the Water Purification Division do not accept certain details of the report, its publication as a "tentative" document is approved by the Division. The material will be set in type and referred for approval to the Committee on Water Works Practice and the Board of Directors. It will be published in the JOURNAL as soon as approval has been received.

22. *Control of Chlorination:* This committee prepared a report of progress, which was published in the December 1942 JOURNAL. Studies with which the committee is in contact give promise of indicating a substantial revision of the chlorine test procedure. This is an important project and is being put forward with all possible diligence by the Chairman and his associates.

23. *Other Committees:* The Water Purification Division is at present reorganizing its committee activities. Committees on:

- Specifications and Tests for Water Purification Chemicals
- Activated Carbon Research
- Standards for Purification Plant Operation

have been discharged, and the activities of the committees have been taken in hand and are held in suspense by the officers of the Division. The Committees on:

- Water Treatment and Laboratory Control
- Fluoride Determination
- Chloramination

have completed their work; their reports have been published and the committees have been discharged.

Finance and Accounting Division Committees

24. *Committee Activities:* The committees of this Division—the Committee on Joint Administration and Collection of Water and Sewer Accounts and the Committee on Lien Laws—are not active under wartime conditions.

Joint Committees

25. *Standard Methods for the Examination of Water and Sewage:* This committee does not propose to issue the ninth edition of the text before the end of 1943. The eighth edition was issued in 1936 and, at the end of 1942, 14,461 copies of the book had been sold. In 1942, 2,262 copies were sold. These figures testify to the value of the document, which, in successive editions, has been a continuing project since 1905, when the first complete edition was prepared by a committee led by George W. Fuller.

26. *Joint Research Committee on Boiler Feed Water Studies:* This inter-association project, organized by S. T. Powell of the A.W.W.A. in 1925, has suspended most of its activities for the duration. At present a study is being made to ascertain whether financial support of, and research personnel for, a research upon the nature and cause of turbine blade deposits can be found under present conditions. While the A.W.W.A. representatives on the executive group of this joint committee approved the suspension of activities during the war, the problem of turbine blade deposits appears to be one which merits study at the earliest possible moment—even, possibly, under war conditions.

27. *American Co-ordinating Committee on Corrosion:* This co-ordinating activity is functioning well under the secretaryship of G. H. Young of the Mellon Institute. The work has as its purpose the recording of all corrosion research wherever it may be located. It has the merit, if sufficiently publicized, of preventing the expenditure of time and money on studies which have already been made elsewhere, but which may not have come to the attention of all persons having a related interest.

28. *Construction Contracts:* This committee has suspended its work for the duration of the war. It now appears, with the attention being given to post-war planning, that the committee could properly make an effort to reorganize its work.

29. *American Research Committee on Grounding:* The report of the Technical Subcommittee of this committee appears in this issue of the JOURNAL. The A.W.W.A. research on grounding at New York University has made less progress than anticipated, primarily because Professor Eliassen entered military service and the Research Laboratory has lacked his close direction. The fellowship has been extended to the end of the current scholastic year and an additional deposit ($500) of A.W.W.A. funds has been made. A progress report has been filed at the A.W.W.A. office. It is hoped to have a final report for this fellowship by June 1943.

30. *Water Works Terms:* No report of activities during 1942 has been received.

31. *Accounting Manual:* No revision of this text is in progress or proposed.

32. *Water Hammer:* No record of this committee activity is at hand.

33. *Survival and Retirement Experience With Water Works Facilities:* A preliminary report has been prepared and, in part, published in the October 1942 JOURNAL. An assembly of tabulations and charts has been prepared and a limited number of copies have been made available to those who wish to study the data. The progress of the study has been retarded by the demands of the war upon water works personnel. This study is a major contribution to the knowledge of water works requirements and those in charge of it are doing all that is currently possible to put the work forward to completion.

34. *Joint A.W.S-A.W.W.A. Committee on Specifications for Field Welding of Water Pipe Joints:* This committee was suggested by the American Welding Society in April 1942. The A.W.W.A. consented to join in the activity and William W. Hurlbut

was appointed General Chairman. The following personnel was subsequently appointed:

A.W.W.A. Representatives
R. B. Diemer
G. W. Hamlin
R. C. Kennedy
L. G. Lenhardt
H. A. Price

A.W.S. Representatives
H. C. Boardman
H. M. Chadwick
M. Ettington
G. H. Garrett
H. O. Hill

Chairman Hurlbut expects to present a progress report for the committee at or before the 1943 Conference.

A.W.W.A. Representation on Committees of Other Organizations

U.S. Bureau of Standards

35. *Simplified Practice Committee on Wrought-Iron and Wrought-Steel Pipe, Valves and Fittings:* The committee was active during the year. At the beginning of 1942, the standing committee approved a revision of the recommendation, as proposed by the Manufacturers Standardization Society of the Valve and Fittings Industry, consisting of the elimination of the 3½-in. pipe in the standard and extra strong weights. This approval was subsequently rescinded after a survey revealed that the 3½-in. pipe size was needed in war production work.

American Standards Association

36. *Cast-Iron Pipe and Special Castings (A21):* A variety of activities of this committee merit recording. The "Specifications for Tar-Dip Coatings" have been approved by the committee. They have been approved by the A.W.W.A., but the other sponsors of A21 have not reported.

The "Specifications for Threaded Cast-Iron Pipe" which were developed by a special joint subcommittee appointed from A21 and A40 have been approved by Committees A21 and A40. They have been approved by the sponsors of A40 and by the A.W.W.A. as one of the sponsors of A21. The other three sponsors of A21 have taken no affirmative action.

Committee A21 has ready for preprinting and circulation among committee members the text of specifications for short radius fittings.

The Chairman and certain members of A21 have maintained close contact with the WPB group which has interested itself in emergency specifications for process pipe. These specifications are being drawn up upon the basis of the "Manual of Design" (A21.1) but follow current emergency procedures in reducing wall thickness, weight, etc., as a measure of economy of critical materials.

37. *Manhole Frames and Covers (A35):* The report of this committee was approved by its sponsors, but neither sponsor was prepared to publish the document. While the A.W.W.A. was not a sponsor, it was represented on the committee, and it was felt that the report should be made available. It was therefore printed in full in the July 1942 Journal. Copies have been printed for the account of the ASA and the type has been torn down.

38. *Plumbing Equipment (A40):* A discussion of several years standing was resolved by the reorganization of this important committee early in 1942. The A.P.H.A. is now co-sponsor with the A.S.M.E. This brings the sanitary engineering viewpoint into the active direction of the enterprise. M. W. Cowles, who formerly represented the A.W.W.A. on certain subcommittees of A40, now represents the A.P.H.A. along with Sol Pincus. Dean F. M. Dawson of the University of Iowa represents the A.W.W.A., with Warren Scott as alternate.

39. *Pipe Threads (B2):* A revision of the "American Standard for Pipe Threads" was completed during 1942. The new bulletin is entitled "American Standard Pipe Threads." The "Specifications, Dimensions and Gaging for Taper and Straight Pipe Threads Including Certain Special Applications" was approved by the ASA in October 1942.

40. *Pipe Flanges and Fittings (B16):* Certain proposed revisions of the "American Standard for Steel Pipe Flanges and Flanged Fittings" urged by the WPB are in progress. The proposed "American Standard for Steel Socket-Welding Fittings" were voted upon in February, but no record of final approval by the ASA has been received. The "American Standard for Cast-Iron Screwed Drainage Fittings was approved in February.

41. *Pressure Piping (B31):* This committee has been very active during the year and has recently released an important document entitled "American Standard Code for Pressure Piping—1942" (A.S.M.E., $2 per copy). The text should be a part of the library of any engineer designing water works steam power plants.

42. *Wrought-Iron and Wrought-Steel Pipe and Tubing (B36):* In connection with the action taken at the 1942 Annual Meeting of the American Society of Testing Materials, the committee is considering the following:

Revision of Standard Specifications for:

- Welded and Seamless Steel Pipe
- Seamless Alloy-Steel Boiler and Superheater Tubes
- Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes
- Electric-Fusion-Welded Steel Pipe (Sizes 30 In. and Over)
- Electric-Resistance-Welded Steel Pipe
- Electric-Fusion-Welded Steel Pipe (Sizes 8 In. to but Not Including 30 In.)
- Electric-Fusion Welded Steel Pipe for High-Temperature and High-Pressure Service

New Tentative Specifications for:

- Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A106–42T) to replace Standard A106–41 (B36.3–1942)

Withdrawal of Standard Specifications for:

- Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A.S.T.M. A106–41; ASA B36.3–1942)
- Lock-Bar Steel Pipe (A.S.T.M. A137–34; ASA B36.7–1935).

The following specifications have been completed and were published in the July 1942 issue of *Industrial Standardization* (ASA):

- Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service (American Standard B36.18–1942)

Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes (American Standard B36.13–1942)

Lap-Welded and Seamless Steel and Lap-Welded Boiler Tubes (American Standard B36.12–1942)

Medium-Carbon Seamless Steel Boiler and Superheater Tubes (American Standard B36.15–1942)

Seamless Alloy-Steel Boiler and Superheater Tubes (American Standard B36.17–1942)

Seamless Steel Boiler Tubes for High-Pressure Service (American Standard B36.14–1942)

Spiral-Welded Steel or Iron Pipe (American Standard B36.16–1942).

43. *National Electrical Code (C1):* Work is in progress keeping the code rules up to date and modifying these rules to fit wartime emergencies. A number of code modifications have been adopted by the Interim Revision Procedure, and the code subcommittees have submitted proposed changes to the 1940 text, but only the most urgently needed ones have been adopted. The others have been suspended for the duration. N.B.F.U. Pamphlet No. 70—Supplement to the 1940 National Electric Code has been issued.

44. *Specifications for Zinc Coating of Iron and Steel (G8):* This committee is inactive.

45. *Letter Symbols and Abbreviations for Science and Engineering (Z10):* Richard Hazen, the Association's representative on this committee, has entered military service and is thereby detached from the activities of the committee. [The Board approved the appointment of Professor W. L. Malcolm of Cornell University to succeed Mr. Hazen.]

The following standards have been promulgated by the committee and approved by the ASA during 1942:

Letter Symbols for Hydraulics

Letter Symbols for Mechanics of Solid Bodies

46. *Sieves for Testing Purposes (Z23):* No work is in progress.

47. *Graphical Symbols for Use on Drawings (Z32):* The proposed revision of the "American Standards for Graphical Symbols for Use on Drawings in Mechanical Engineering" was approved by the sponsor bodies and has been presented to the ASA with recommendation for approval as an American Standard. These graphical symbols were published in the A.W.W.A. JOURNAL (February 1942).

The proposed "Standards for Graphical Symbols for Electric Power, Control and Measurement" have been submitted to this committee for consideration.

"Welding Symbols and Instructions for Their Use" have been prepared by the Committee on Symbols of the American Welding Society and presented to Sectional Committee Z32 in order that they might be presented to the sponsors for approval as an ASA American Standard.

American Welding Society

48. *Inspection of Welded Structures:* The "Specifications for Inspection of Welded Structures" were completed and published in the *Welding Handbook* for 1942, by the A.W.S.

National Fire Protection Association

49. *Forests:* No projects were completed during 1942.

50. *Hydrants, Valves and Pipe Fittings:* A progress report was pub-

lished in the *N.F.P.A. Quarterly,* May 1942, Part 2 (Proceedings of 46th Annual Meeting).

51. *Public Water Supplies for Private Fire Protection:* No projects were completed during 1942.

52. *Tanks:* No projects were completed during 1942.

Advisory Members on Special Committees

53. *Drinking Water Standards:* The U.S.P.H.S. Committee on Drinking Water Standards appears to have discharged its responsibility with the completion of the report and its promulgation by the Surgeon General. No advice relating to termination of responsibility of the committee has been received from the U.S.P.H.S.

54. *New York City Board of Health:* The representative of the A.W.W.A. reports no action has been required from the committee since its inception. It appears advisable to terminate the relationship.

Emergency Specifications

During the year 1942, H. Arthur Price was requested to act as editor for proposed Emergency Specifications for Asbestos-Cement Pipe. Ernest Whitlock was requested to act as editor for a similar document to cover Reinforced Concrete Pressure Pipe. The two sets of proposed specifications are scheduled for discussion during the Board meeting.

Respectfully submitted,
MALCOLM PIRNIE, *Chairman*

Appendix—Action by the Board

Following presentation of the above report, the Board of Directors discussed and took action upon the recommendations included. The more important decisions were:

Action on the "Specifications for Asbestos-Cement Pipe" was deferred indefinitely.

The "Specifications for Steel Plate Pipe" (as submitted by the committee) are to be amended in line with certain suggestions discussed by the Board and then sent through the approval routine. They will be published as soon as approved.

The "Specifications for Coal-Tar-Dip Coatings for Cast-Iron Pipe were discussed at some length. Further discussion is to be made part of the General Conference in June.

The "Emergency Specifications for Reinforced Concrete Pressure Pipe" were modified in certain details and accepted. The document will be sent to the Board for approval and thereafter published in the JOURNAL.

Report of the Publication Committee

1. The Journal

a. Text Contents: During 1942, the JOURNAL contained 2146 pages of papers and abstracts. Included were these reports:

(1) Committee Report on Cross-Connection Control

(2) Progress Report (1941) of American Research Committee on Grounding

(3) American Standard Graphical Symbols for Use on Drawings

(4) Report of the Committee on Water Works Practice

(5) Tentative Manual of Safe Practice in Water Distribution

(6) Emergency Alternate Specifications for Sulfate of Alumina

(7) American Standard Manhole Frames and Covers (A-35)

(8) Standard Schedule for Grading Cities and Towns—National Board of Fire Underwriters

(9) Progress Report No. 1 of the Committee on Survival and Retirement Experience With Water Works Facilities

(10) Committee Progress Report on Control of Chlorination

(11) Committee Report on the Value of Sodium Hexametaphosphate in Corrosion Control

(12) Emergency Alternate Provisions for Tentative Specifications for Cold Water Meters

(13) Revisions of Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs

The Report of the Audit of Association Funds for the year ending December 31, 1941, was published in the March JOURNAL. The December JOURNAL included: the report of the 1942 Conference; listing of Papers Scheduled at Section Meetings; and the Table of Contents and the Index for the year.

In addition to the items cited above 179 articles were published in the JOURNAL. Of these, 148 articles were Conference or Section Meeting papers or contributions emanating from the field; and 31 articles were releases from WPB, Selective Service, etc.

b. Abstracts: A total of 299 pages of abstracts was published in 1942.

c. Advertising: Actual space of advertisements was 468 pages in the 1942 JOURNAL, compared with 490 pages in 1941. The amount of space contracted for 1943 by January 14 was 421 pages. Since the total volume of advertising is never contracted by this date, anticipated renewal of contracts terminating during 1943 warrants the expectation of at least as much space sale as last year.

d. Total Pages: The total of the above cited pages, including the News of the Field and the official pages at the front of the JOURNAL, was 2908 pages.

(A 48-page booklet, containing the Conference speech of J. A. Krug and other vital water-war information, was

mailed to all members on July 15, 1942. This was made in the JOURNAL format to permit binding it with the annual volume.)

e. Format: In 1942, the JOURNAL's text type page size was increased from $4\frac{1}{8}$ in. by 7 in. to $4\frac{1}{2}$ in. by $7\frac{1}{3}$ in. The abstracts type page had previously been in this larger size and in two columns. Detailed studies made in 1942 indicated the advisability of changing the text format to two columns and further increasing the type page, since this would not only save paper and money, but also, being more easily read, would save readers' time. These changes and results may be tabulated thus:

	1941	1942	1943
Size, Text Type Page, *in.*	$4\frac{1}{8}$ x 7	$4\frac{1}{2}$ x $7\frac{1}{3}$	$4\frac{5}{8}$ x $7\frac{1}{2}$
No. Characters, Full Page Typeset Text	2665	3022	3563
Year's Allotment, Text Pages, Incl. Tables and Illus.	1800	1650	1374
Avg. Monthly	150	137	115
Size, Abstract Type Page, *in.*	$4\frac{1}{2}$ x $7\frac{1}{3}$	$4\frac{1}{2}$ x $7\frac{1}{3}$	$4\frac{5}{8}$ x $7\frac{1}{2}$
No. Characters, Full Page Typeset Text	4247	4247	4701
Year's Allotment, Abstract Pages	255	255	240
Avg. Monthly	23	23	22

For 1943, a change of typeface was made, to obtain one that seemed more attractive, more readable and one setting more words in a given space.

f. Change of Printers: Concurrently with the detailed study of formats, a careful comparison was made of the plants, equipment and costs for JOURNAL production of several printers. Due chiefly to A.W.W.A. production requirements, all but the 1909–1942 printer (Waverly Press at Baltimore) and the Lancaster Press at Lancaster, Pa., were eliminated. A tabulated comparison, indicating a minimum saving of 10 per cent to be made by changing printers, was placed before the Association's Executive Committee and upon this basis the change was made, effective with the January 1943 issue.

The total saving by changing printers will amount to \$2385, or more, in 1943. In addition, a further saving obtains from the change in format, wherein fewer pages are required for the same number of words.

g. Paper Stock: For 1943, the paper stock purchase routine has been much simplified, to the benefit of the Association. Lancaster Press makes no charge for storage, so that item is eliminated. The Association now pays the paper manufacturer's distributing office direct, which is financially advantageous. The Lancaster Press will give the Association a record each month of the amount of paper consumed and the amount remaining in stores.

h. Censorship: The Association began immediately to co-operate with the Board of Economic Warfare when that organization started last March, to control publications going to foreign countries. The first issue "censored" was the May number. The policy adopted has been that nothing would be printed in the JOURNAL which has not been passed for export to our allied countries, this upon the assumption that material published here and widely circulated could be photoprinted or abstracted and so passed on through neutral countries not receiving publications by second class mail.

The Association's staff has had excellent service from the New York branch of BEW's censor, receiving very prompt review of galley proofs and prompt decisions on manuscripts submitted before typesetting.

Some information, especially on poison gases, has been mimeographed and

passed on to the state sanitary engineers for such dissemination as they saw fit.

2. Membership Directory for 1942

a. Production: Editing was expedited to produce the Membership Directory in June, before the A.W.W.A. Conference. Increasing the column widths to 13 picas effected some economy. A total of 6000 copies was printed, the additional ones being distributed to new members joining after June 1942.

b. Advertising: Following up the expressed interest of some Associate Members in increasing the value of the Directory, the Association's office sold to Associate Members $1649.60 worth of advertising space in the publication.

c. Index of Members' Products: Through the medium of a comprehensive mailing, the "Classified Index of Products and Services" was developed

Distribution of A.W.W.A. Publications During 1942

Title	Pub. during 1942 or available for sale	Balance 1/1/43	Distr. in 1942	Distr. in 1941
Books				
Manual of Water Quality and Treatment	694	247	447	695
Cumulative Index—1881–1939	419	387	32	188
Manual of Water Works Accounting	79	34	45	72
Specifications				
Manual for Computation of Strength and Thickness of Cast-Iron Pipe—A21.1–1939	486	429	57	1875
Cast-Iron Pit-Cast Pipe—A21.2–1939	559	471	88	1486
Cement Mortar Lining for Cast-Iron Pipe—A21.4–1939	386	359	27	1743
Special Castings—Cast-Iron (1908)	488	238	250	1070
Laying Cast-Iron Pipe—7D.1–1938 (6 x 9)	346	72	274	156
(8½ x 11)	26		26	72
Riveted Steel Pipe—7A.1–1940	55	22	33	40
Lock-Bar Pipe—7A.2–T	97	72	25	53
Large and Small Welded Steel Water Pipe—7A.3–1940 and 7A.4–1941	360	7	353	646
Protective Coatings for Large and Small Steel Pipe—7A.5 and 7A.6–1940	530	150	380	878
Cement-Mortar Coating for Steel Pipe—7A.7–1941	133	115	18	157
Gate Valves—7F.1–1938	243	30	213	373
Sluice Gates—7F.2–T	490	429	61	10
Fire Hydrants, etc.—7F.3–1940	309	241	68	1377
Elevated Steel Water Tanks, etc.—7H.1–1941 (6 x 9)	286	160	146	1291
(8½ x 11)	200	200		1000
Cold Water Meters—Displacement Type—7M.1–T	200	107	93	
Recommended Practice for Distribution System Records	765	300	465	45
Water-Borne Outbreaks	122	99	23	68
(Emergency Alternate Specs.) Sulfate of Alumina (8½ x 11)	2000	829	1171	
(6 x 9)	125	125		

to serve as a complete reference to Associate Members' products.

3. Index to Journal and Proceedings

Of the 1000 copies made in 1940, there remain 387 copies. This stock should be further reduced by promotional activities during 1943.

4. Standard Methods for the Examination of Water and Sewage

Reference to this activity is contained in the report of the Water Works Practice Committee (p. 320). The co-operative arrangement with the A.P.H.A. for editing and publishing this text, which has been in effect since 1925, continues to be satisfactory.

5. Manual of Water Works Accounting

During 1942, 45 copies were sold, compared with 72 copies in 1941 and 49 copies in 1940. A promotional mailing to a selected list should promote additional sales in 1943. A total of 585 copies have been sold by the A.W.W.A. The M.F.O.A. has disposed of a like number. The Association's representatives (Messrs. Hal Smith, John C. Flanagan and M. F. Hoffman) on the joint committee, as well as the staff of the M.F.O.A., are of the opinion that the *Accounting Manual* does not need revision now, but, rather, that greater distribution and appreciation of the present text should be obtained.

6. Sales of Specifications Documents

a. Large Lot Sales: These were at a minimum in 1942, because such sales are to manufacturers, who were not making many promotional direct mailings in 1942.

b. Sales of Single Copies: Such sales to operators, engineers and military bases were numerous.

c. "A.W.W.A. Publications": This 4-page folder was used extensively to promote small sales and was distributed at numerous section meetings.

7. Manual of Water Quality and Treatment

From the 1000 copies printed and collated, but not previously bound, 250 were bound in order to meet the continued sales of this *Manual.* In 1942, 448 copies were sold, compared with 695 in 1941. A total of 2003 copies have been sold; 247 finished copies are in stores; and 750 copies in the form of unbound signatures are in stores. The Publication Committee recommends that the Water Works Practice Committee begin now to set up its organization for the production of a new Manual of Water Quality and Treatment.

Respectfully submitted
LINN H. ENSLOW, *Chairman*

January 14, 1943

Progress Report

American Research Committee on Grounding

DURING the year July 1, 1941, to July 1, 1942, the activities of the American Research Committee on Grounding were continued through investigations by the Technical Subcommittee. Although the work was impeded by the urgency of the war effort, all cases referred to the committee were investigated.

Inspections were made at seventeen locations, of which sixteen were on Long Island and one was in Pennsylvania. These are summarized in Table 1.

Progress was made in the laboratory tests on the effect of current on water pipes, being conducted at New York University under the sponsorship of the American Water Works Association.

No reports were received from the British Electrical and Allied Industry Research Association on its investigation of grounding.

Field Investigations

Inspections were made on Cases 85 to 101 inclusive. As in the past, an investigation was made in each case where an unsatisfactory water condition was reported. Wherever practicable, investigations were also conducted at other locations in the immediate vicinity, for purposes of comparison. Notes on some of these investigations are given below.

Cases 87 to 90: The situation in an area supplied by a particular water district was brought to the attention of the committee by an official of a Department of Health on Long Island. In Case 87 blue water stained white laundry and a silicon-bronze water storage tank failed from corrosion. Stomach or intestinal disturbances resulted from drinking water which had stood in the pipes for some time.

Altogether, four locations in this water district were inspected. All of these had unusually long water service pipes. Three, which experienced blue water, had copper tubing for interior piping. Two of these had $1\frac{1}{4}$-in. and 2-in. copper services and one had a 4-in. cast-iron service. Case 88, which did not experience blue water, had yellow brass interior piping and a 1-in. copper service pipe. With unbalanced loads connected to the electric services in the basements, the locations experiencing blue water had between 2 and 39 per cent, and the location without blue water, 23 per cent, of the unbalanced load current on the water service.

Submitted by H. S. Warren, *Chairman*, 420 Lexington Ave., New York; C. F. Meyerherm, *Secretary,* Pres. & Engr., Albert F. Ganz, Inc., 511 Fifth Ave., New York; and H. E. Kent, *Secretary, Technical Subcommittee.*

TAB

Summary of Investigations,

Case No.	Location	Complaint	Neutral Ground	Percentage of Unbalanced Load Current on Pipes: Water Service† A	Water Service† B	Gas Service	Direct Current	Type of Wiring
85	Long Island	Rust in water from hot water storage tank	Water pipe	47	43	—	Slight	Armored cable
86	Pennsylvania	Green stains	None	0	0	0	None	Knob & Tube
87	Long Island	Corrosion of copper tank, blue stains on wash, sickness from drinking the water	Water pipe	23	2	7	None	Armored cable
88	Long Island	None	Water pipe	23	0	—	—	Armored cable
89	Long Island	Blue water	Water pipe	2	0	—	—	Armored cable
90	Long Island	Blue water	Water pipe	39	8	12	—	Armored cable
91	Long Island	Blue water	Main	0	0	0	None	—
92	Long Island	Blue water	Water pipe	22	3	—	—	Armored cable
93	Long Island	Blue water stained wash	Water pipe	16	21	21	—	Armored cable
94	Long Island	Blue water stained brush bristles and corroded aluminum kettle	Water pipe	25	9	8	—	Armored cable
95	Long Island	None	Water pipe	40	60	60	—	Armored cable
96	Long Island	Corrosion of copper pipe	Water pipe	52	14	0	Slight	Armored cable
97	Long Island	Corrosion of copper pipe & tank	Water pipe	58	10	0	Slight	Armored cable
98	Long Island	Corrosion of copper pipe	Water pipe	24	18	13	None	Armored cable
99	Long Island	Corrosion of copper tank	Water pipe	19	2	7	—	Armored cable
100	Long Island	Corrosion of copper tank	Water pipe	12	6	14	—	Armored cable
101	Long Island	Corrosion of copper pipe	Water pipe	21	11	0	—	Armored cable

* Where several consecutive cases were in the same water

† Water Service: A—Street Side of Grounding Connection;

LE 1

*July 1, 1941 to July 1, 1942 **

Water Piping Material					Apparent Source of Trouble	Notes
Main		Service	House	Hot Water Tank		
Pipe	Joints					
Cast iron	Universal	Copper	Copper	Galv. iron	Defective tank	Tank Replaced
Cast iron	Lead	Copper	Copper & lead	Galv. iron	Aggressive water	Telephone ground blamed, but customer satisfied to let it alone
Cast iron	Universal	Copper	Red brass	(*See* Note)	Aggressive water	Silicon bronze tank failed from corrosion—replaced with monel tank
Cast iron	Universal	Copper	Yellow brass	Copper	No trouble	Inspected with Case 87
Cast iron	Universal	Copper	Copper	Galv. iron	Aggressive water	Inspected with Case 87
Cast iron	Universal	Cast iron	Copper	Galv. iron	Aggressive water	Inspected with Case 87
Cast iron	—	—	Copper	None	Aggressive water	Pumphouse at deep well 20 ft. of copper tubing to lavatory
Cast iron	Lead	Copper	Copper	Copper	Aggressive water	Water partially aerated in elevated tank
Cast iron	Lead	Copper	Copper	Copper	Aggressive water	
Cast iron	Lead	Copper	Copper	(*See* Note)	Aggressive water	Galvanized iron tank replaced with copper on account of rust; copper tank replaced with monel on account of blue water
Cast iron	Lead	Galv. iron	Galv. iron	Galv. iron	No trouble	Inspected with Case 94
Cast iron	Lead	Copper	Copper	Copper	Moderately aggressive water	Cases 96 to 101 in new development. Tank failures occurred at welded seams
Cast iron	Lead	Copper	Copper	Silicon bronze	Moderately aggressive water	
Cast iron	Lead	Copper	Copper	Silicon bronze	Moderately aggressive water	
Cast iron	Lead	Copper	Copper	Silicon bronze	Moderately aggressive water	
Cast iron	Lead	Copper	Copper	Silicon bronze	Moderately aggressive water	
Cast iron	Lead	Copper	Copper	Silicon bronze	Moderately aggressive water	

district, the case numbers are bracketed.
B—House Side of Grounding Connection.

The water in this district is supplied from deep wells and is not treated. Samples were collected from the three cases which had blue water and the analyses showed the water to have almost identical characteristics, except as to copper content.

Case 91: This case of blue water was at a pumphouse over one of the deep wells supplying a water district on Long Island. Twenty feet of 1-in. copper tubing carried water from the discharge line from this well to a lavatory in the pumphouse. There was no current on this tubing under any condition of load. The water showed a slight blue color and a blue stain was found in the white lavatory.

Case 94: This case, also on Long Island, was at a residence with copper tubing for both service and interior piping. When rust was found in the hot water a galvanized-iron hot-water tank was replaced with a copper tank. Subsequently, the presence of blue water prompted the owner to replace the copper tank with one made of monel metal. This, however, did not stop the blue water. The committee was shown a toothbrush on which the bristles had turned green as a result of the water. At this house, also, an aluminum teakettle was so severely corroded that it was eaten through at several points and an analysis of the sediment on the inside showed the presence of copper. With an unbalanced load of about 12 amp., there were 3 amp. (25 per cent) on the water service pipe and 1 amp. on the interior piping.

Case 95: During the inspection of Case 94, reference was made to a house in the same vicinity where no troubles were experienced. The committee found the service and interior piping in this residence was of galvanized iron. The hot-water storage tank was of galvanized iron, supplied from a small coal stove. Current measurements showed 40 per cent of the load current on the water service pipe on the street side of the ground wire and 60 per cent on the house side of the ground wire, with no current returning on the neutral conductor. It was found later that this was an open circuit in the neutral conductor of the customer's underground service cable.

Cases 96 to 101: These cases included several homes in a new development, started about three years ago, all of which had copper services fed from cast-iron mains and copper tubing for interior piping. Of the six locations visited, one had experienced both pipe leaks and failure of hot-water storage tank, two had experienced pipe leaks, two had experienced tank failures and one had no trouble from corrosion, although the presence of corrosion products on the outside of the pipes had indicated to the owner that trouble should be expected soon. All tank leaks inspected occurred in welded seams. The three pipe failures occurred in piping above the first floor ceiling, associated with upstairs bathrooms. In one case, the hole in the ceiling was still open, and inspection showed that the failure was a pinhole which had been repaired by soldering. Current measured with a test load plugged in a receptacle in the bathroom showed no current in the pipe that had failed. In another group of eight of the older houses in this development, which were not investigated, most of the storage tanks had been replaced.

All of the houses in this development had been built by the same concern and were similar in electric service and in heating and water supply piping

arrangements. With unbalanced loads on the electric service, the current on the water service was between 12 and 58 per cent of the unbalanced load. The current on the interior piping was between 2 and 18 per cent.

Cases 71, 73, 74, 75: These cases, discussed in the report for last year (Jour. A.W.W.A., **34**: 69 (1942)), involved four residences where blue water was being experienced and where a special transformer arrangement was installed in order to eliminate all alternating current from the services and piping of two of the residences. Water analyses have been conducted from time to time on samples from each of the four houses and, so far, about eight samples have been analyzed from each building, covering a period from September 1940 to February 1942. Although current had been eliminated from the two residences for a period of sixteen months, the copper content, which varied considerably from time to time in all of the houses, showed no consistent differences in the analyses of samples obtained from the homes without current as compared with samples from the homes with current on the piping. Variations in amount of usage of water may account for some of the differences in copper content.

Pipe Tests

The previous report of activities, dated August 15, 1941, mentions that the American Water Works Association has sponsored a program of pipe tests to be conducted at New York University. These tests have now been set up, but have not progressed to a point where the results are indicative. Members of the subcommittee have been co-operating with the personnel of New York University in setting up the circuits for putting a measured amount of current on some of the pipes and in the technique to be used in operating the polarograph.

The water drip test also referred to in the previous report has been discontinued as it came to be felt that no conclusive evidence would be obtained by this test.

Changes in Committee Membership

There have been two changes in the Technical Subcommittee membership, affecting the working personnel. A. I. Heim has been representing the Copper and Brass Research Association in place of Carter S. Cole, who is now doing some special work for the United States Government. R. Pope has replaced P. W. Spence for the A.S.A. Telephone Group.

Future Work

Although the conduct of the work of the Technical Subcommittee has been hampered by change of personnel and pressure of other work resulting from war activities, it appears at present that the committee will be able to continue to function if conditions do not become more restrictive. It is hoped to investigate all cases of unsatisfactory water conditions which are brought to the committee's attention.

The committee will also continue to keep in close touch with the water pipe tests being conducted at New York University.

A report summarizing the activities of the American Research Committee on Grounding since its formation, which was proposed in the report of last year, has not been prepared and it is felt that, under the conditions now existing, the preparation of such a report must be deferred.

Report of the Audit of Association Funds for the Year Ending December 31, 1942

To the Members of the American Water Works Association:

The By-Laws require that the Secretary shall have made an annual audit of the books of the Association.

The records for 1942 have been examined by the staff of Louis D. Blum & Co. The complete record of that examination follows.

Reference may be made to past audits which appeared in the JOURNAL as follows: pp. 520–25, March 1938; pp. 570–74, March 1939; pp. 516–20, March 1940; pp. 774–78, April 1941; and pp. 426–30, March 1942.

There is also submitted a membership statement for 1942 and a comparative record for 1933–42 inclusive.

Respectfully submitted,
HARRY E. JORDAN, *Secretary*

February 3, 1943

TO THE AMERICAN WATER WORKS ASSOCIATION:

We have examined the balance sheet of the American Water Works Association as of December 31, 1942, and the statements of income and expenses and surplus for the year then ended, have reviewed the system of internal control and the accounting procedures of the Association and, without making a detailed audit of the transactions, have examined or tested accounting records of the Association and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

In our opinion, the accompanying balance sheet and related statements of income and expenses and surplus present fairly the position of the American Water Works Association at December 31, 1942, and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed)
LOUIS D. BLUM & CO.
Certified Public Accountants

EXHIBIT A—Balance Sheet, December 31, 1942

Assets

Cash in Banks and on Hand		$26,243.61*
Deposit—United Air Lines		425.00
Accounts Receivable:		
Advertising	$1,829.40	
American Public Health Association	1,589.20	
Water and Sewage Works Manufacturers Association	1,875.00	
Reprints	70.25	
Other	70.51	5,434.36
Membership Dues		168.58
Accrued Interest on Bonds		326.04
Inventories:		
Type metal	$323.28	
Manual of Water Quality and Treatment (247 copies)	370.50	
Cumulative Index (387 copies)	464.40	
Manual of Water Works Accounting (34 copies)	49.30	
Sundry publications	394.69	
Membership certificates	13.50	
Fuller Memorial Award certificates	43.13	
Back issues—Journal—Vols. 1 to 33, inclusive (24,945 copies)	—†	
Back issues—Proceedings—1881 to 1926, inclusive (324 copies)	—†	1,658.80
Office Equipment (Less Depreciation)		3,280.73
Investments, per Schedule 1:		
Investments at cost	$58,831.36	
Excess of redemption value of United States Savings Bonds over issue price	2,400.00	61,231.36
1943 Convention Expense		39.09
Total Assets		$98,807.57‡

Liabilities and Surplus

Accounts Payable	$107.99
Membership Dues—Advance Payments	11,832.63
Unearned Subscriptions to Journal	1,114.00
Reserve for Award Fund (McCord)	154.56
Reserve for Expenses of Carbon Research Committee	48.46
Surplus, per Exhibit C	85,549.93*
Total Liabilities and Surplus	$98,807.57

* Canadian funds in the Bank of Montreal as at December 31, 1942 amounted to $1,008.78, which, if converted into U.S. currency at that date, would have resulted in a loss of approximately $116.01. Had this loss been recorded, the cash in banks and the surplus would have been decreased correspondingly.

† Back issues of Journals and Proceedings are inventoried, but no money values are assigned to them for balance sheet purposes; the costs of these issues were charged off during the years of publication.

‡ On December 31, 1942, a fund of $100.00, which is not reflected in the balance sheet, was held by the Association to be used as membership promotion awards for the year 1942; this fund was disbursed during January 1943 to the winners of the awards.

EXHIBIT A, Schedule 1—Investments, December 31, 1942

Security	Principal Amount	Date of Maturity	Purchase Price
City of Los Angeles 3½s	$2,000.00	1960	$2,241.11
Canadian Victory Bonds 3s	6,000.00	1956	5,647.75
International Telephone and Telegraph Co. 5s	3,000.00	1955	2,895.00
Province of British Columbia 4½s	1,000.00	1951	1,000.00
Province of Ontario 4½s	2,000.00	1946	1,690.00
Province of Ontario 4s	1,000.00	1964	732.50
Southern Pacific Railroad Co. 4½s	5,000.00	1977	4,875.00
United States Savings Bonds—Series C (issue price)	5,250.00*	1947	5,250.00
United States Savings Bonds—Series C (issue price)	7,500.00†	1948	7,500.00
United States Savings Bonds—Series D (issue price)	7,500.00‡	1949	7,500.00
United States Savings Bonds—Series D (issue price)	7,500.00§	1950	7,500.00
United States Savings Bonds—Defense Series G (issue price)	10,000.00‖	1953	10,000.00
United States Savings Bonds—Defense Series G (issue price)	2,000.00¶	1954	2,000.00
Total Securities	$59,750.00		$58,831.36
Excess of redemption value of United States Savings Bonds—Series C and D, over issue price to December 31, 1942			2,400.00
Total Investments			$61,231.36

* Maturity value at May 1, 1947—$7,000.00.
† Maturity value at December 1, 1948—$10,000.00.
‡ Maturity value at March 1, 1949—$10,000.00.
§ Maturity value at January 1, 1950—$10,000.00.
‖ Maturity value at September 1, 1953—$10,000.00 (Redemption value at December 31, 1942 ($9,780.00).
¶ Maturity value at November 1, 1954—$2,000.00 (Redemption value at May 1, 1943 ($1,976.00).

EXHIBIT B—Statement of Income and Expenses for the Year Ended December 31, 1942

Operating Income:		
Annual dues	$44,873.75	
Advertising	28,493.31	
Subscriptions to Journal	2,572.56	
Convention registration fees	5,722.00	
Convention—other events	1,074.44	
Water and Sewage Works Manufacturers Assn.	7,500.00	
Interest on investments*	1,800.19	
John M. Goodell prize	75.00	
Miscellaneous interest income	14.54	
Total Operating Income		$92,125.79
Publication Income:		
Sales of Manual of Water Quality and Treatment	$1,131.46	
Sales of Manual of Water Works Accounting	134.40	
Sales of reprints	1,518.08	
Sales of Cumulative Index	50.75	
Sales of membership certificates	50.00	
Sales of Proceedings and Journals	640.89	
One-half of profits from sales of Standard Methods of Water Analysis	1,589.20	
Sales of specifications—miscellaneous	124.85	
Sales of specifications—meters	5.20	
Sales of specifications—cast-iron pipe	38.22	
Sales of specifications—steel pipe	414.70	
Sales of specifications—elevated steel tanks	42.78	
Sales of specifications—gate valves	54.76	
Sales of specifications—fire hydrants	45.26	
Sales of specifications—sluice gates	5.55	
Total Publication Income		5,846.10
Total Income (carried forward)		$97,971.89

* This account includes:

Interest earned on bonds	$1,077.69	
Increase in redemption value of U.S. Savings Bonds, Series C and D	740.00	
Premium on redemption of Alabama Power Company Bonds	87.50	1,905.19
Less: Loss on redemption of Province of Ontario Bonds		105.00
		$1,800.19

Total Income (brought forward)			$97,971.89
Operating Expenses:			
Directors' and Executive Committee Meetings:			
Travel expense	$2,399.47		
Stenographic expense	197.89		
Executive Committee expense	20.00	$2,617.36	
Administrative Expense:			
Rent	$3,000.00		
Office supplies and services	3,582.46		
Membership promotion	194.53		
Auditing expense	407.10	$7,184.09	
Administrative Salaries:		31,033.14	
Committee Expense		504.75	
Division and Section Expense:			
Division expense	$24.75		
Section—membership allotment	5,661.75		
Section—official travel	2,038.75		
Section—general expense	154.54	7,879.79	
Journal:			
Printing	$23,187.35		
Abstractors	654.77		
Membership list—1942	2,074.56		
Storage—Journal paper stock	76.00	25,992.68	
Convention:			
General	$2,051.72		
Entertainment	4,926.86		
Management Committee	285.45		
Publicity	551.27	7,815.30	
Membership Dues in Other Associations		575.00	
John M. Goodell Prize		75.00	
Fuller Memorial Award		8.62	
Depreciation of Office Equipment		473.85	
Miscellaneous Expense		256.88	
Total Operating Expenses		84,416.46	
Cost of Publications Sold:			
Manual of Water Quality and Treatment	$421.47		
Manual of Water Works Accounting	108.34		
Reprints	1,348.40		
Cumulative Index	37.65		
Membership certificates, including lettering and mailing	42.10		
Specifications:			
Miscellaneous	71.66		
Meters	7.12		
Cast-iron pipe	18.39		
Steel pipe	333.62		
Elevated steel tanks	15.49		
Gate valves	26.45		
Fire hydrants	31.24		
Sluice gates	2.53		
Total Cost of Publications Sold		2,464:46	
Defense Committee		2,559.16	
Development Expenses:			
Research—electric grounding	500.00		
Research—depreciation—water works structures	676.57		
Total Development Expenses		1,176.57	
Total Expenses			90,616.65
Net Income for the Year (Transferred to Exhibit C)			$7,355.24

EXHIBIT C—SURPLUS ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1942

Balance, January 1, 1942	$78,194.69
Add: Net income for the year, per Exhibit B	7,355.24
Balance, December 31, 1942, per Exhibit A	$85,549.93

Membership Statement for the Year 1942

	Active	Corporate	Associate	Honorary	Junior	Affiliate	Total
Total, January 1, 1942	3,473	345	216	28	20	95	4,177
Changes in membership grades	+7	−1	+1	+3	−7	−3	—
	3,480	344	217	31	13	92	4,177
Gains:							
New Members	483	60	9	—	9	9	570
Reinstatements	51	5	2	—	—	1	59
	4,014	409	228	31	22	102	4,806
Losses:							
Resignations and Deaths	115	2	7	2	1	5	132
Dropped for non-payment of dues	204	17	2	—	1	9	233
Total, December 31, 1942	3,695	390	219	29	20	88	4,441
Total, January 1, 1942	3,473	345	216	28	20	95	4,177
Gain in 1942	222	45	3	1	—	−7	264

Comparative Statement—Gains and Losses—Ten-Year Period

Year	New	Reinstated	Resignations and Deaths	Suspended for Non-Payment of Dues	Gain or Loss	Total Members at End of Year
1933	168	56	159	234	−169	2,221
1934	271	66	86	122	+129	2,350
1935	565	42	85	190	+332	2,682
1936	311	53	104	218	+42	2,724
1937	515	86	122	139	+340	3,064
1938	520	59	144	140	+295	3,359
1939	578	64	112	179	+351	3,710
1940	514	58	113	212	+247	3,957
1941	480	92	116	236	+220	4,177
1942	570	59	132	233	+264	4,441
Total	4,492	635	1,173	1,903	+2,051	—

Abstracts of Water Works Literature

Key: In the reference to the publication in which the abstracted article appears, **34:** 412 (Mar. '42) indicates volume 34, page 412, issue dated March 1942. If the publication is paged by the issue, **34:** 3: 56 (Mar. '42) indicates volume 34, number 3, page 56, issue dated March 1942. Initials following an abstract indicate reproduction, by permission, from periodicals, as follows: *B.H.—Bulletin of Hygiene (British); C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (British); I.M.—Institute of Metals (British).*

WARTIME WATER WORKS PROBLEMS

Vancouver Agrees to Chlorinate District's Water Supply. ANON. Can. Engr.—Wtr. & Sew. **80:** 12: 24 (Dec. '42). Question of chlorinating Vancouver water supply, ordered by Dominion Dept. of Pensions & National Health under powers conferred on it by order-in-council, having been placed on sole basis of national defense and made applicable only for duration of war, administration board of Greater Vancouver Water District has agreed to adopt chlorination. Cost of installation of necessary equip. estd. at **$75,000–$100,000,** and of maintg. it until end of war will be borne by Dominion Govt.—*R. E. Thompson.*

Water Hygiene in War. W. S. LANGE. Dtsch. Militarartzt (Ger.) **5:** 324 ('40); Zbl. Ges. Hyg. (Ger.) **47:** 425 ('41). Hygiene of water supplies small but important part of province of hygiene experts in field. Sources of water found in occupied country must be examd. immediately and good supplies made known and protected from poln.; unsuitable sources of supply should be marked clearly or made unusable. In field, vol. of water of 10 l. per head per day must suffice under some circumstances. Often necessary to use rain water. When large quants. of water not required, supply can be obtained by pipe wells (Abyssinian wells). War conditions may cause damage to water works and to distr. systems, and broken sewers may cause poln. of supplies. Examn. of water in field must be restricted to most important points. Inspection of source must never be omitted. Usual methods of bact. examn. too slow for use in field. Author recommends detn. of total count on agar at 37°C. Chem. and phys. anals. cannot be carried out under mobile conditions, but must be resumed when more stable conditions attained. Rules given for chlorinating water in field. Filtration in addn. to chlorination beneficial.—*W.P.R.*

Water Supplies Checked. *U.S. Public Health Service.* ANON. Mil. Surgeon **91:** 602 (Nov. '42). Water of unsatisfactory qual. supplied by municipalities to several military reservations being checked. 2 U.S.P.H.S. mobile labs. used in making tests. Samples collected for bact. examn. Close contact with water works supts. maintd. to keep cognizant of plant conditions at all times. Cl_2 residuals high enough to make water supplies safe must be assured.—*Ralph E. Noble.*

The Recognition of Impurities in Water. F. C. HILTON-SERGEANT. J. Roy. Army Med. Corps (Br.) **78:** 3: 122 (Mar. '42). Early recognition of addn. of poisonous substances to water supply, as result of enemy action, of first importance. After inspection of suspect area for possibilities of poisoning, anal. for poisons must be done before arrangements made for clarification and sterilization of drinking water. Anal. concerned with phys. characteristics of water, possible presence of poisons, quant. of water-sterilizing powder required and, under certain conditions, suitability of water for sedimentation with coagulant. Turbidity, color and odor simple tests which may indicate contamn. Turbid water imposes heavy strain upon filtering equip., and odor from particular water may become more marked when sample warmed. Color may be important if any special dye used for

marking poisoned sources. Colored and turbid waters will have greater chlorine demand as shown by Horrocks test, and deviation of large quants. of chlorine suggestive of presence of mustard gas. On other hand, persistence of small dose of chlorine in sample is proof of absence of mustard gas, a fact which considerably enhances value of Horrocks test. For purposes of sedimentation, knowledge of pH of water required. Use made of indicator bromthymol blue, which is yellow at pH 6 and blue at, roughly, pH 8. Optimal range for sedimentation is in green range of this indicator [pH 6.4 to 6.8]. Lime added to a water that is too acid and alumino-ferric used as coagulant. In examg. for poisons in water, following tests carried out: (1) Sulfide test for heavy metals such as lead, mercury, bismuth and copper. Lead can be recognized in as small a quant. as 1 ppm., if control used, and safety limit of lead in water is 1 ppm. for not more than a week. (2) Modified Marsh test for arsenic. Arsenic may be deliberately added to water as sodium or potassium arsenite (sheep dip) or contamn. may be caused by nasal irritant gases—D.M., D.A. and D.C. (latter also contg. cyanide); lewisite, although hydrolyzed by water will, nevertheless, leave certain arsenical products therein. Calcium arsenide, on coming into contact with moisture, will liberate arsine, which has little or no smell, is non-irritant to eyes, nose, respiratory passages and skin, but, on absorption into the blood-stream *via* lungs, causes widespread haemolysis of red cells, with resulting haemoglobinuria and jaundice. Arsenic can be detected by modified Marsh test in as small a concn. as 5 ppm.; upper safety limit of arsine is 5 ppm. for short periods and 1 ppm. for long periods. *Gutzeit* test another very effective test for arsenic, but inclusion in Army Poisons Box not practicable. These tests do not detect organic arsenicals in water, so that if lewisite or nasal irritant gases suspected, arsenic must first be converted into inorg. state by boiling sample with little caustic soda before testing. (3) Cyanide detected by well-known Prussian-blue (ferric ferrocyanide) reaction. Test sensitive down to 20 ppm., and consumption of 45 ppm. in water tolerated for short periods. (4) Iodo-platinate test for mustard gas detection. Thiodiglycol, hydrolytic product of mustard gas, acts similarly. As, chlorine and nitrites also give the reaction, however, these must be destroyed by boiling sample with hydrochloric acid and urea (or fresh urine in an emergency). Thiodiglycol not destroyed by this treatment and, if present, is shown by appearance of blue color on addn. of iodo-platinate, and starch and salt solns. In general, water supplies will not be affected by non-persistent gases, but nasal irritants will have to be especially considered owing to possibility of arsenical contamn. of water, for example, in shell holes. Persistent lachrymator, such as B.B.C. and possibly K.S.K., may render water supply unapproachable and, therefore, unusable for many days. So may a persistent lung irritant, e.g., chloropicrin, owing to its associated lachrymatory action. Lewisite is rapidly hydrolyzed by water, but, as already indicated, causes arsenical contamn. which must be removed before water fit for drinking. Lewisite remains liquid at much lower temps. than mustard gas, so that its use in cold climates and seasons is possible. Mustard gas soluble in water only to extent of 1 in 1,000. In contamd. supply there may be scum of liquid mustard on surface, some dissolved mustard in supernatant and liquid mustard at bottom. Hydrolysis of gas in water slow and products, hydrochloric acid and thiodiglycol, are, to all intents and purposes, harmless. Water contamd. with mustard should not be used either for drinking or ablution purposes, but if no alternative source available and if sedimentation of liquid has taken place, water may be abstracted from source by means of strainer floated 6″ to 9″ below surface. After filtering it is allowed to stand and is then sterilized by super-chlorination. Water contg. mustard gas can be made safe by boiling for ½ hr.—products of hydrolysis may render water somewhat unpalatable, but are innocuous. Oily globules held back by slow gravity sand filtration; if excavation is made short distance away from shallow source, water which filters through will contain dissolved mustard only, which can be dealt with by super-chlorination. —*B.H.*

Protection Against Poisonous Gas (Civilian Defense). Lewis E. Harris. Neb. Munic. Rev. *No.* 221: 8 (Dec. '42). Civilian defense decontamn. unit responsible for protection against gas, its removal from bldgs., sidewalks, etc., and for emergency first aid treatment of gas casualties (*cf.* Jour. A.W.W.A. **34:** 1157 ('42)). Many munics. overlooked importance and do not have specifically trained group for purpose. Although gas attack appears unlikely, not impossible. Common sense, therefore, to train protective unit. Latter valu-

able in event saboteur gas-bombs pub. gathering. Decontamn. unit should be separate group of 10 to 20 as nucleus specifically trained in gas work and without other duties. Training should include methods of protecting civilians in gas attacks, first aid treatment of gas casualties and gas removal. After training, divide into chem. and medical sections. Former primarily to protect civilians and remove gas under leadership of chemists or pharmacists when possible. Latter primarily to give first aid and supervise removals to hospitals under leadership of physicians and nurses when possible. Publications dealing with training of decontamn. units listed.—*Ralph E. Noble.*

Emergency War Repairs in Water Systems. D. W. JOHNSON. Internatl. Engr. **82:** 156, 174 (Nov., Dec. '42). Best way to make emergency war repairs to water system is preparedness. Danger from bombing or sabotage. Following items should be given special study and protection when community supply depends upon single unit as: deep well, reservoir, intake, supply source, transmission main, chlorinator, transformer bank, pumping station, elevated tank. Responsibilities of employees for maintg. system service should be divided among respective depts., with emphasis on section heads. Distr. supt. should study possible bombing effect from standpoint of: (1) message transmission from bombing point to control supply yard or emergency directing center; (2) closing valves on broken mains to regulate and control flow; (3) necessary repair to mains. *Maps of Distr. Systems:* First step in preparedness, checking valve maps with actual locations so indicated to facilitate finding at night. Should check valve operation and immediately repair those needing it. *Repair Urgency of System Sections:* Study each section of main supplying principal mercantile dist. to det.: (1) valves to close for stopping flow in any particular block, (2) how long section can be out of service without seriously lowering pressures elsewhere, or interrupting service. In case of long pipeline from lake reservoir or river, store materials at several points along same. If enemy can put water system out of commission to handicap fire dept., conflagration would destroy city. *Servicing Distr. System:* Distr. studies may indicate immediate installation of addnl. valves or short runs of pipe to tie transmission mains together to give more flexibility under bombing. Emergency labor should be arranged for well in advance. Broken mains have been allowed to discharge into bomb craters and pumpers to take suction from such artificial cisterns.

Crater Sizes in Sandy Loam by Delayed Action Fuse Bomb

Bomb Size, lb.	*Penetration, ft.*	*Diam. of Crater, ft.*	*Earth Displaced, cu.yd.*
100	6	20	25
300	11	27	75
600	17	37	225
1,100	26	45	500
2,000	39	50	950

Temporary Repairs: Speed of repair of first importance as fire and san. facilities out of service during main shut-off. Permanent repair advised unless addnl. time needed would cause fire hazards in area. By study, prepn. and practice, time for repairing broken main reduced from 7 to less than 2 hr. per break. Temporary main repairs speeded up by using smaller diam. jumpers across crater on piers or around edge on earth shoulders. Short run, 30′ to 50′ pipe of ½″ cross-sectional area of parent pipe, only reduces pressure ½ psi. or less, unless large no. of such emergency repairs in same line. Small diam. jumpers much more easily handled under air raid conditions. Friction losses due to 50′ small-sized pipe installed across bomb crater shown for velocities of 2, 3 and 4 fps. in 12″, 24″, 30″, 36″ and 48″ mains. Std. lead joint used if time allows, but mech. gland type quicker, requires fewer tools and has greater flexibility in later trench settlement. Several special fittings made up with mech. joints suitable for quick repair illustrated. Good supply of these and solid sleeves should be on hand. *Repairing Pipe Breaks:* Sq. break across pipe barrel quickly repaired with only mech. joint split sleeve. If solid sleeve and bell end piece of pipe used with poured lead joints, main would be out of service several hr. Lead joints loosened by vibration should be re-driven and provided with rubber-faced clamps to prevent leak recurrence with ground settlement around crater. Extra-long-bodied sleeves, about 24″, suggested for covering jagged edges of broken mains. One end equipped with mech. gland joint, other either bell and spigot, mech. joint or other preferred type. Before re-laying main, should backfill crater hole to el. equal to top of pipe or other suitable founda-

tion provided. Wooden cribbing should be used at close intervals to reduce beam action on pipe. Use tie rods on fittings when pressure high or fittings over 12″ diam. *Water Supply:* Should establish addnl. sources of supply whenever possible, especially for suburban cities around large metropolitan areas. Inter-connections installable at small cost may prevent serious conflagration. Neighbor co-op. another form of preparedness. Small isolated cities may arrange connection with large private indus., but such private supply should be approved by state health authorities before connection. *Sterilizing Water Mains:* Sterilization of all sections should be part of regular repair work. Good high veloc. flushing of all new work one of simplest and most effective sterilization methods, especially for broken mains in bomb craters allowing sewage, mud, debris and other foreign material to enter during shut-down. Liberal amts. of Cl_2 compds. should be kept on hand for quick sterilization of broken mains.—*Ralph E. Noble.*

Mobile Power Unit for Emergency Needs. ANON. Eng. News-Rec. **129:** 560 (Oct. 22, '42). Trailer-mounted elec. power plant with sufficient capac. to drive motors as large as 75 hp. part of disaster preparedness equip. of East Bay Munic. Utility District, Oakland, Calif., for use in event of prolonged power interruption at pumping or filtration plants. Main unit 60-kw., 480-v., 3-phase, 60-cycle generator driven by direct-coupled 90-hp. gasoline engine. A 9-kva. transformer supplies power for 220-v. motors up to 10-hp. and 1-kva. transformer provides 110-v. current for lighting and small equip. Two fuel tanks with combined capac. of 240-gal. enables operation at full load for about 28 hr.—*R. E. Thompson.*

Strategy and Tactics on a Wartime Water Works Project. EDWARD J. CLEARY. Eng. News-Rec. **129:** 474 (Oct. 8, '42). As result of defense and war production programs, water consumption in Hampton Roads area of Virginia has increased from 24 to 40 mgd., and estd. that future demand may be as high as 72 mgd. Safe yield of present supplies estd. at 43 mgd., but 2-yr. drought has shown this to be optimistic. Consequently, need of addnl. supplies urgent and all non-essential uses prohibited. Work resolved itself into 2 major undertakings, on opposite banks of James R. Newport News, on north side, undertook constr. of 32-mi. pipeline tapping Chickahominy R. and leading to existing storage reservoirs, is bldg. new 6-mgd. filter plant and enlarging existing one. Norfolk and Portsmouth, on south side, supplied from adjacent but independent lakes, seeking addnl. water from Blackwater and Nottaway Rivers, involving 19-mi. pipeline to existing lakes. In addn., Norfolk increasing capac. of large reservoir, building 18-mi. transmission line from lake to city and enlarging filter capac. by 12 mgd. Portsmouth planning addnl. 6-mgd. filter plant. Need of telescoping several years' work into period of months necessitated unusual measures, including negotiating contracts on basis of prelim. plans and unit prices with designs to follow, laying temporary line above ground from Nottaway R. to tributary of Blackwater R. in case of continued drought, prepg. for reversal of flow in Blackwater R., using steel reinforcing shell of concrete pipe for part of temporary line owing to lack of time to make completed pipe, converting 2-stage pump into 2 units, securing second-hand motors for driving latter and using combination of 34″ and 39″ concrete pipe for line designed for 36″ pipe because forms for latter not available. Details of these measures included.—*R. E. Thompson.*

Substitute Materials. ANON. Western Constr. News **17:** 492 (Nov. '42). Some revised suggestions for highway constr. applicable to water works constr. Critical, moderately critical and available materials grouped. In place of usual materials, following substitutes recommended for purpose indicated: *Concrete forms:* No removal steel forms used except those already fabricated. *Cribbing:* Treated timber or gravity type concrete. *Dowell caps:* Cardboard or other suitable substance. *Elec. equip:* Reconditioned used motors for operating pumps, etc. *Expansion bolts:* Ferrous material with non-metallic coating. Fastening with lead permissible. *Expansion joint filler:* Bituminous or other suitable substance. *Fence:* Wood where possible. Ferrous metal wire fencing not more than 2 lb./lin.ft., or not more than 0.33 lb./sq.ft., mounted on wood posts, and without metallic top rails, permitted. Ferrous metal gates and gate posts allowed for openings wider than 10′. Zinc coating permitted on wire mesh only. *Gratings:* Concrete and wood as far as possible. *Guard fence:* Wooden rail on wooden posts alone, or stone. *Gutters and*

downspouts: Wood, asbestos-cement pipe, terra cotta, painted or zinc-coated ferrous metals or lead. *Manholes:* Brick, plain concrete or vitrified clay. *Manhole covers and frames:* Reinforced concrete or wood. *Masonry anchors, clamps and ties:* Uncoated or non-metallic coated ferrous metal. *Nails:* Uncoated ferrous metals where climate and usage permit. *Paint:* Red, blue, white lead available for essential uses. *Pipe:* Wood, asbestos-cement pipe or reinforced concrete where practical. *Piling:* Use timber cofferdams as much as possible. *Riprap:* Loose rock where available. If concrete only suitable material, use in bulk, not reinforced, not in burlap bags.—*Ralph E. Noble.*

Creosoted Water Tanks Save Steel for War. Anon. Ry. Eng. & Maint. **38:** 696 ('42). Growing out of shortage of steel similar to that which confronts railroads today, Illinois Central (I.C.) began 25 yr. ago to build creosoted wood water tanks in place of steel tanks. Results satisfactory and this railroad now has 164 such tanks in service, including the first one erected in '17. Avg. life of untreated redwood, cypress and white pine tanks little over 30 yr. and good grade of this material now practically unobtainable. Inspection after 25-yr. service indicates ultimate life of creosoted yellow pine tanks may exceed 50 yr. I.C. has detailed framing plans for 3 std. sizes including towers, of 30,000-, 50,000- and 100,000-gal. capac. After seasoning for at least 3 mo., all timbers preframed before treatment, to elim. any cutting or drilling in field. Full-cell process used with retention of 15 to 16 lb. of creosote. No difficulty encountered with fire losses or contamn. of water. Tanks can be dismantled, moved and re-erected without seriously affecting useful life. *R. C. Bardwell.*

The Supply of Technical Men to the Armed Forces and to Industry. R. L. Sackett. Science **96:** 553 (Dec. 18, '42). To ensure continuous flow of young engrs. to armed forces and indus., serious concern to natl. eng. societies. In Oct. '42, Engrs. Council for Professional Development drew up statement emphasizing need for adequate supplies of young technical men. In Nov., Am. Inst. of Chem. Engrs. strongly recommended: (1) Loss of technically trained men from war plants be stopped by cessation of voluntary enlistment or by "freezing" order covering such personnel and plants. (2) Selective Service Bul. No. 10 of last June be reaffirmed in principle in its provisions for deferment of men in eng. training. (3) This directive be modified in light of lower draft age by providing for deferment of eng. students in established colleges to end of term reaching 18, and thereafter on term to term basis as long as academic records satisfactory. On Dec. 4, council of Am. Soc. of Mech. Engrs. resolved that effective war effort demands adequate supply of engrs. be ensured for armed forces and war indus. through deferment of certain students in eng. colleges under following conditions: (1) Enrollment in college with curriculum professionally accredited by Engrs. Council for Professional Development. (2) Completing not less than 1 term or 1 semester's work in accredited professional curriculum in eng. with avg. grade at least equal to that required to graduate. Resolution sent to President, Chairman of WMC and Director of Selective Service. On Dec. 8, Consultative Com. on Eng. for Professional and Tech. Div. of WMC unanimously adopted following: Recognizing necessity for continuing flow of professionally trained men for war indus., especially for urgent developmental work in improving qual. and production of actual weapons and warfare materials, this organization (named) respectfully recommends WMC Chairman immediately take necessary steps to provide temporary deferment from military service for those undergraduates in recognized eng. schools who are subject to Selective Service. Such deferment necessary pending more thorough study of eng. manpower requirements by war indus. and armed forces. This recommendation confirms and re-emphasizes resolutions made by eng. societies mentioned above. Not a recommendation for class deferment but recognition of temporary situation requiring prompt and decisive action to prevent serious crippling of war program.—*Ralph E. Noble.*

The Engineering College Research Association. Anon. Science **96:** 510 (Dec. 4, '42). 73 eng. colleges in U.S. organized ECRA to co-op. with govt. war agencies and war indus. in prosecution and promotion of needed research. Structure closely resembles Office of Production Research and Development set up by WPB. Close liaison between ECRA and other govt. and private research agencies will be maintd. to utilize vast research facilities of

eng. colleges. Will co-ordinate research activities of eng. college labs. and personnel in vital studies affecting war materials and production; assist organizing research facilities of eng. colleges in studies to promote post-war reconstr. and economic adjustment through new and improved processes affecting indus., pub. works, conservation and development of natural resources and pub. health; act as continuing agency for developing and co-ordinating indus. and scientific research and for furthering advanced study in eng. colleges of U.S. Such co-op. avoids expensive and wasteful duplication of effort, affords max. utilization of facilities and personnel with high deg. of co-ordination.—*Ralph E. Noble.*

The Fuller Utilization of Scientific Resources for Total War. T. ROSEBURY. Science **96:** 571 (Dec. 25, '42). Nation's scientific resources still far short of full mobilization for war. Scientific workers' deepest interest as citizens, in common with all others, threatened to their foundations. Total war demands utmost eff. in leadership from above, and alike in co-op. from below. Workers in phys. and math. sciences, engrs., physicians, dentists and veterinarians absorbed into war effort so rapidly that shortages becoming critical. Among chemists, author's experience shows more "business as usual" than tolerable. Although they contribute to phys., eng. and med. front lines, chem. warfare, development and improvement of synthetics, substitute materials, therapeutic agents and other biol. products, not all competent chemists being used. Med. sciences, including physiology, bio-chem. and bacteriology, seem still further behind goal of full utilization. Being utilized, however, under effective leadership of Com. on Med. Research (CMR), one sub-div. of govt's. Office of Scientific Research and Development (OSRD). Biologists and agric. scientists have no central govt. agency like CMR, with funds and power to initiate and co-ordinate war research. Implies no serious criticism of OSRD leadership to say its efforts to date afford no basis for complacency. This organization and supporting agencies, however, not expected to envisage all possible scientific war work, or reach down to every scientific worker and find proper job for him without requiring and encouraging each to find own place and help others likewise. OSRD set-up provides for such individual volunteer effort. Details given. This provision not widely publicized, not extensively in practice, and usefulness impaired by required secrecy imposed on war research by military authorities. Secrecy essential in many such problems but regulations not adequately clarified and, in practice, often more severe than need be. Experience of bact. group in New York cited to indicate some means available to encourage and facilitate volunteer activity. Organized through N.Y. branch of assn. and now autonomous body considering aspects of bacteriology and related sciences of current war importance. 7 problems suggested and plans made to prep. OSRD contract applications. Scientific workers lacking facilities or qualifications for war research work can: (1) aid in training civilian defense workers, participate directly in local civilian defense organizations as gas detection experts, med. assistants or engrs. for control or rehabilitation in disaster areas after enemy attack; (2) prep. directions and help institute precautions for storage or disposal of potentially dangerous materials in labs., factories and homes; (3) prep. pamphlets or books popularizing scientific data for civilian defense workers, education and morale-building among armed forces. Beyond goal of full utilization of scientific resources lies problem of their most efficient utilization. As exigencies of total war become more apparent, and need for outright conversion of all science to war purposes made inescapable, may become imperative that all scientific activity be centralized and co-ordinated by single govt. agency. Bill (S. 2721) with essentially this purpose introduced Aug. 17, '42. Provides for Office of Technological Mobilization to survey, mobilize and co-ordinate all tech. personnel and facilities of nation for max. war effort. *Discussion. Ibid.* **97:** 67 (Jan. 15 '43). F. C. WHITMORE: Discusser objects to statements that chemists are "on a business as usual" basis and that more complete use found in war work for phys. chemists than for those in other categories. Indus. units divisible into 3 categories, each requiring more chem. service in war than peacetime: (1) those which have always made war materials, e.g., T.N.T. and armor plate; (2) those normally filling necessary civilian needs continuing during war and shared by armed forces, e.g., food; (3) those producing goods non-essential to armed forces or civilians, now largely shifted to war work where same talent needed on latter. Chemists doing "business as usual" constitute our only chemical reserve, already too small.—*Ralph E. Noble.*

Australian Association of Scientific Workers. Anon. Nature **150:** 494 (Oct. 24, '42). Assn. of Scientific Workers held conferences Feb. 21–22 and Mar. 7–8, '42. Apparent deep misgivings whether govt. understood and appreciated what could be done by scientifically trained persons given problems to solve. Opinion expressed that scientific men themselves should perceive existing problems needing immediate soln., anticipate inevitable new ones and suggest methods of soln. and disposal. Discussed lack of understanding of indus. fatigue; absence of suitable groups to study same in factories; inability to utilize experience gained elsewhere; short-sightedness in planning for supplies, especially in agric. and in pooling information of plant practices; and waste of scientific manpower in fighting forces. —*Ralph E. Noble.*

ADMINISTRATION, ACCOUNTING AND FINANCING

Problems in Municipal Administration. A. E. Berry. Eng. Cont. Rec. **55:** 15: 32 (Apr. 15, '42). Discussion of munic. admin. with particular reference to water works and to conditions in Ont. In most Canadian municipalities, councillors and other representatives elected annually. Little desire expressed for appointee commission forms of govt. or one-man city mgrs. Elected councillors formulate policies and appointed civic officials administer them, electors having annual opportunity to approve or disapprove. Relationship between elected and appointed servants discussed rather fully. Fortunately, appointed staff, even in smaller centers, seldom changes to any marked extent following changes in councils. Ont. has much higher percentage of utilities commissions than other provinces, probably due to fact that publicly owned hydroelectric systems usually commission-controlled, and water systems, great majority of which publicly owned, frequently combined with them. Basic principle in Ont. legislation that all money obligations shall be debt against munic. and not alone against works created by expenditure. Authorization of public expenditures for water works resulting in creation of debt obtained in Ont. by: (1) vote of rate payers, (2) endorsement by munic. bd., or (3) mandatory order by Provincial Dept. of Health. Yearly installment plan of repaying debts has largely superseded sinking fund method. Municipal act specifies max. of 30 yr. for debt retirement. Many systems meet all charges from sales revenue; others levy frontage or local improvement taxes. Legislation regarding surplus water works funds confusing and practice varies widely. Councils sometimes adopt attitude that since rate payers at large must assume financial responsibility for water works they should be entitled to any surplus. Water works financing should be based on certain general principles, including service at cost, full payment for services rendered and equitable charges on those who derive benefits. No more justification for practice of supplying free water to public bldgs. than for providing fire protection out of revenue from water consumers. Water works seldom taxed in Canada, but no serious objection is in order, providing utility is paid for all services rendered. —*R. E. Thompson.*

Duties and Responsibilities of a Water Commissioner. T. A. Filipi. Neb. Munic. Rev. *No.* 215: 3 (June '42). Comr. first should develop sufficient enthusiasm for job and water plant to sell service to pub. and governing bd. He produces and distributes commodity used by more people than any other utility or business can supply. To impress consumers with treatment benefits, one softening plant operator pumps untreated water 1 day/mo. Practice keeps public satisfied and enthusiastic about supply. Water comr.'s duty: to maint. water works system at peak of performance; to make certain sufficient no. of wells, intakes, other sources of supply available to meet demand peaks; to keep pumps, engines, motors, piping, etc., in condition to prevent breakdown when demand greatest; to take every known precaution to keep supply up to drinking water stds. and observing state health dept. requirements as to frequency of sampling and submission of samples for bact. examns., Cl_2 and pH, other control tests; to maint. proper and adequate records of pumpage, elec., oil, lime, alum used, pumps, motors, feeders, other phys. equip., maps of distr. system showing location of various pipes, valves, hydrants. He should plan for future; set aside money for maint. and growth; plan extensions and replacements; check adequacy of entire system against changing demands to det. weak points and avoid breakdowns; keep abreast of improvements in science of water works practice;

check compliance with all state laws, rules, regs. and ordinances by governing boards.—*Ralph E. Noble.*

Some Notes on Water Works Management. Ernest Stace. Wtr. & Wtr. Eng. (Br.) **45:** 47, 94 (Aug., Sept. '42). Water Works Clauses Act of 1847 limits profits which may be made. Powers given to any two ratepayers to bring authorities before court for report on accts. and court may order reduction of water rate. Marked difference between borrowing powers of privately owned and munic. water works. Latter have obligation to repay. Possible that municipality could pay off all of its capital. Consumers would then enjoy very low rate. Act provides power to break up streets to supply water, but may not enter on private land except subject to payment of compensation to damaged person. Act provides that authorities obligated to provide supply of pure water sufficient for domestic use. Service pipes laid by inhabitants under superintendence of company. Water rate payable in advance on usual quarter days and levied on annual value of premises. There are penalties in plenty, mainly directed to prevention of waste, misuse, undue consumption, theft of water, damage to pipes, etc. Mgr., under and responsible to his board, should have sole control, delegating responsibilities to skilled people. Secretary, who is statutory officer, should be an accountant. Acctg. for money will require watertight system of cost acctg. Payment of wages should be by pay-clerk. New consumers are addnl. burden and bldg. water charge is, therefore, means of recovering connection fee and not a charge for water. Particulars recorded are that builder has paid for connection to one house. From details in journal, ledger card prepd. for house which shows net annual value and rate to be collected quarterly or semi-annually. Demand note (statement of acct.) has perforation to enable right-hand portion to be removed and used for posting in ledger. Receipts are machine-recorded. It prints receipt on both demand note and stub. In case of non-payment within a month, first notice should be sent followed by cut-off notice. Refunds of overpayments should be dealt with through expenses dept. Capital expenditures must be made for industrial supplies and debt charges for this will spread over whole community, which has no guarantee that rates in factory will provide adequate set-off. Deposits equal to one quarter's consumption should be required of factories. Metered supplies may be necessary for other than trade supplies. Waste inspection important feature of control. Engineer's office should keep equip. sheets up to date, with details of mains, valves, etc. Directors will require from mgr. detailed report at monthly meetings. Periodically, rental dept. will produce comparative statements. With his staff and workers, mgr. must stand *in loco parentis* and be accessible for welfare and discipline.—*H. E. Babbitt.*

Britain's Water Supply. Anon. Munic. J. & Local Govt. Admin. (Br.) **50:** 796 (June 26, '42). Br. Water Works Assn. in constant touch with 5 govt. depts. re water problems. Comprised of 131 water supply undertakers (local councils or joint bds.), 399 water authorities in Empire. Represents capital expenditure about £300 million. Total avg. pop. supplied estd. to be greater than 40 million. 50 sources of supply dependent upon rivers, 140 upon deep wells and boreholes, others on gravitation gathering grounds and deep well pumping. At Ministry of Health invitation, Assn. represented on Cent. Advisory Com. Govt. desires advice on: (1) questions re conservation and allocation of water resources, (2) execution of or proposed amendments to water laws, (3) making appropriate gen. recommendations.—*Ralph E. Noble.*

Philadelphia Cuts Water Waste. Anon. Eng. News-Rec. **129:** 292 (Aug. 27, '42). 3 water systems supplying more than 90% of 2,500,000 water users in 5 counties of Philadelphia area have total max. capac. of 460 mgd., 20 mgd. above max. peacetime demand. Estd. in May that demand would reach 500 mgd. by late summer, and, in June, campaign to reduce water consumption conducted by appeals to public through leaflets, posters, newspaper stories and radio addresses. Local councils of defense in 5 counties co-operated, and local water depts. increased inspection and repair of hydrants and valves. Consumption reduced 30 mgd. in June compared with June '41, despite 25% increase in use by war industries and expanded pop. Estd. that actual reduction in consumption for non-essential purposes 65 mgd. (*cf.* Jour. A.W.W.A. **35:** 173 ('43)).—*R. E. Thompson.*

Losses as a Cause of Gain. George O. May. J. Accountancy **72:** 221 (Sept. '41). In business economy in which corporate form of organization predominant and in large sec-

tions of which substantial portion of capital employed normally secured in form of loans, depression of great severity bound to have important and some unexpected results. Surprising is situation in which losses have been deemed to cause gains. Illusion possible due to corporation acctg. being maintd. on cost basis, while dealings in securities representing interests in corporation based on commercial value. Assumption made consciously or unconsciously that future will be like present or recent past. Years ago capital value presumed equal about ten times annual profits, thus one dependent upon other. In late Twenties criticism of corporate structure made up largely of loans, reply was criticism betrayed a lack of appreciation of power of leverage. Retirement of debt at less than face value does not in itself produce income. Where bond reacquired at discount, necessary to consider why corporation able to consummate such a transaction. When all bonds of Am. companies listed on N.Y. Stock Exchange were selling at about 53% of par and preferred stocks 29%, as in June '32, discounts obviously a reflection of unfavorable prospects for future of enterprises, rather than of fluctuations in interest rates. Recognition of unsound results that would follow from acceptance of view that retirement of debt at less than face value necessarily produces immediate income has led to an alternative suggestion. Argued that retirement should be regarded as reducing effective cost of assets of enterprise to corporation as owner of equity, and that amt. of reduction should be reflected in income, as those assets are consumed or disposed of in operation. Operating losses, by impairing commercial value of loan capital of enterprise to extent of multiple of such losses, may, and in recent years frequently did, make it possible for corporation to retire loan capital for far less money than had been originally contributed in respect thereof. Unsound acctg. to consider transactions as producing gains which can properly be regarded as income, while decline in value of enterprise itself is, under accepted acctg. rules, rightly ignored.—*Samuel A. Evans.*

Can the Continuing Property Records Pay Their Way? JOSEPH B. KLAINER. Pub. Util. Fort. **27:** 596 (May 8, '41). Required acctg. technique in N.Y. State. Considerable section of utilities have been grappling with problem; now there appears desire to utilize their potential value. How can information made available by them be utilized to compensate for large initial non-recurring cost and smaller continuing expense? Used as means for more automatic regulatory procedure. In addn. there must be effective utilization of facts obtained in carrying out functions of management, to justify expenditure for them. To accomplish this, definite plans must be formulated to utilize available information. One tangible benefit detn. of proper amt. of insurance protection against property damage. To collect insurance, detailed listing of property essential; compensation must be such that equivalent replacement of property may be made; fluctuation in price level involved accurate continuing information on property protected. Continuing property record (CPR) basic source of this information. Difference of opinion as to proper method of detg. depn., yet each method requires information provided by CPR. Availability of accurate and detailed inventory and cost information and its use will result in more accurate ests. of constr. work. Instead of special work for each occasion, record is available. Supervision, however, essential so that record will fulfill purpose. Highly important when pressure being applied for purchase or rate reduction. CPR must be planned and executed so information available and of use to all depts. in utility and serve to answer investigators and regulatory bodies.—*Samuel A. Evans.*

What Is an Asset? JAMES L. DOHR. J. Accountancy **73:** 213 (Mar. '42). In prepg. statements of financial position, accountant endeavors to present summary of facts with respect to financial or pecuniary matters in 2 groups—favorable as to financial position and unfavorable. Favorable: ownership of valuable property, ability to pay debts and obtain credit, earning power, freedom from govtl. restrictions, exclusive privileges, etc. Accountant endeavors to reduce all to money basis. On balance sheet asset is favorable factor in financial position susceptible of satisfactory valuation; legally corresponds closely to concept of property. Franchises, patents, good will, trade marks, leaseholds, contracts, etc., may be listed as assets provided there is satisfactory base of valuation. Ordinarily conceived, acctg. processes developed with view to showing financial position of enterprise through medium of a balance sheet. Statement frequently misunderstood as showing present worth of enterprise, profit and loss acct. being regarded as subsidiary statement

showing some changes between balance sheets. Submitted this concept be abandoned; primary purpose of acctg. processes to record gains and losses, showing how proprietary capital increased or decreased. Balance sheets simply connecting links of series of income statements. Financial statements understood by proper consideration of historical development. Article includes examples of assets to be included and excluded in balance sheet.—*Samuel A. Evans.*

Relative Value of Utility Systems. C. F. LAMBERT. Eng. News-Rec. **128:** 678 (Apr. 23, '42). Value of 5 utilities, water works, elec. light plants, street railways systems, and natural and artificial gas plants, originally published on May 7, '25, brought up to Jan. 1, '42. Data for water works based upon 68 items in 25 systems, including land, boilers, pumps, pipe, valves, hydrants, meters, standpipes, reservoirs, filter plants, etc. Tables and graphs show values on '13 and '26 bases, annual trend, preceding 5- and 10-yr. avg. trends and monthly values during '41. On basis of '13 value = 100, monthly values for water works in '41 progressively increased from 196.0 in Jan. to 202.1 in Dec., avg. for yr. being 199.1. On basis of '26 value = 100, value in '41 was 105.8.—*R. E. Thompson.*

LAW, LITIGATION AND LIABILITIES

City Water Supply—Licensing by State Health Department of Person in Charge. *State* ex rel. *Dept. of Health of N.J.* v. *City of Hoboken*, 23 A. (2d) 587; (Jan. 9, '42)). Pub. Health Rpts. **57:** 1359 (Sept. 4, '42). N.J. statute provided no municipality should appoint person in direct gen. charge of water-supply system unless holding dept. license. Term "water-supply system" not defined in statute but state health dept. adopted resolution defining as "system comprising structures which, operating alone or with other structures, result in derivation, conveyance (or transmission) or distr. of water for potable or domestic purposes." Dept. regulations (regs.) established 4 groups of systems and required licenses for operating only those which employed purif. and treatment. Jersey City supplied water to Hoboken. Latter merely distributed it, performing no other function in premises. In suit brought by state at relation of state health dept., alleged Hoboken owned water supply system and appointed supt. in direct gen. charge, unlicensed by dept. Sought to enjoin operation until license obtained. N.J. Ct. of Chancery dismissed complaint on grounds Hoboken not amenable to state dept. regs. re license classifications because city neither obtained water supply from any of 4 groups of systems nor employed any purif. or treatment methods mentioned. Also pointed out state statutes distinguished between "water-supply" and "water-distr." systems and, in this case, Hoboken merely distributed water supplied by Jersey City. Ct. justified Hoboken's challenge of state health dept.'s right to define implication of legislature's term "water-supply systems." Such right resides in cts. According to ct., no evidence offered by complainant that Hoboken had water-supply system within intendment and meaning of statute on which suit based. Neither did legislature ordain that elected official, like city comr., required to take out license mentioned in statute.—*Ralph E. Noble.*

The Plan of the Water Laws of the German Reich. P. GIESEKE. Dtsch. Wasserw. (Ger.) **36:** 57 ('41); Zbl. Ges. Hyg. (Ger.) **48:** 145 ('41). Plan for water laws in German Reich published by President of "Akademie für Deutsches Recht." Need for unification of water laws pointed out. Existing laws must be incorporated in new law, and regulation of water supplies must be under public control. Plan is in three parts: first part concerned with watercourses; second deals with other waters; and third contains general considerations. Among subjects dealt with in proposed laws are use of watercourses for disposal of waste waters, ownership, utilization and protection of ground waters and protection of drainage area when ground water used for supply.—*W.P.R.*

The Driller and the Law. *Insist on Written Contracts.* A. L. H. STREET. The Driller **16:** 1: 17 (Jan. '42). Any landowner naturally reluctant to pay for well and get only hole in ground. Dishonest landowner apt to claim driller guaranteed abundant supply of good water. Guard against such claims by reducing every drilling contract to writing and signatures by both parties, making certain contract wording specific as to driller's under-

taking and that no agreements or representations exist, not embodied therein. *Case*—Wis. Supreme Ct. (96 Northwestern Reporter 561): Driller sued to recover bal. due on well. Landowner admitted some terms of agreement, but demanded refund of amt. paid because driller failed to fulfill guaranty to leave well in proper condition to obtain sufficient supply of water. Supreme Ct. held in favor of driller in view of common knowledge that regardless of skillful work, obtaining supply of good water uncertain. *What Is a Well? Ibid.* **16**: 3: 16 (Mar. '42). *Case*—Koch *v.* Fishburn (164 N.E. 721, 90 Ind. App. 287): Koch owned land on which was 16′ dug well with bored hole at bottom. Employed driller, Fishburn, to construct well, agreeing to pay $1.40 per ft., including cost of necessary pipe. Driller did not expressly agree to discover or produce supply of water, but drilled 4 separate holes, 35′ to 128′, to rock without finding water. Work abandoned and owner refused to pay bal. due. Driller filed mechanic's lien within 60 days required by Ind. law to recover. Trial judge awarded and Ind. Appellate Ct. upheld judgment in favor of driller. Held statute allows mechanic's lien for labor and materials used in constructing, altering, repairing or removing certain things, including a well. Latter is hole dug in ground to obtain water. Objective may not be attained, but failure does not prevent hole so dug from being a well. No merit in contention that complaint does not allege performance. Driller did not agree or guarantee to drill well that would produce water in any quant. or qual. *Two Points Worth Knowing. Ibid.* **16**: 6: 16 (June '42). (1) In suit over question whether well drilling contract properly performed, witnesses must ordinarily confine selves to statement of facts; not permitted to state mere conclusions. (2) Mere fact driller failed to do something necessary to facilitate flow of water, if any found, will not prevent him collecting pay where no water found. *Case*—Yeager *v.* Long Bros. Drilling Co. (147 S.W. (2d.) 276, decided by Tex. Ct. of Appeals). *Hard Contracts Not Fault of the Courts. Ibid.* **16**: 6: 17 (June '42). Cts. can only det. terms agreed upon by contracting parties. They cannot make contracts for them, nor relieve one from burdens of contract voluntarily assumed. Frequently decided if well driller guarantees certain conditions of well to be drilled by him, he has no right to recover for work or materials supplied but not producing guaranteed result. Decided by Iowa Supreme Ct. *Case*—Jackson *v.* Cresswell (61 Northwestern Reporter 383). *Well Must Be Straight and Perforated. Ibid.* **16**: 8: 16 (Aug. '42). *Case—C. . . .* Well Drilling Co. *v.* Givens (206 Cal. 468, 274 Pac. 966, decided by Calif. Supreme Ct.): Co. sued to recover compensation for drilling well and to foreclose on mechanic's lien. Suit framed to permit recovery either on ground of express contract or for reasonable value for services rendered. Trial ct. said co. failed to make out case and Supreme Ct. confirmed. Contract provided well to be drilled sufficiently straight and plumb to permit installation of deep well turbine pump. Brought out that large quants. of gravel removed from lower levels resulting in caving. Evidence to show much more sand ordinarily caves into slanting well than into one straight and plumb. According to indications, well not perforated after drilling. Not specified in contract, but practice considered integral and necessary part of drilling. Foreman testified as having done so under direction, but evidence indicated perforation inadequate. Plaintiff failed to recover for value of services because well of no use or value to defendant. *Open Wells Must Be Kept Covered. Ibid.* **16**: 9: 13 (Sept. '42). *Case*—Tucker *v.* Draper (62 Neb. 66, 86 N.W. 917): Open well on vacant lot in heart of Lincoln, Neb., where owner permitted ball playing. Only covering consisted of loose boards. Local health officer warning that well unsafe disregarded. Later, boy fell in and drowned. Neb. Supreme Ct. held owner liable in damages. *Case*—Holt *v.* S. & P.R. Co. (4 Idaho 443, 40 Pac. 56): Idaho Supreme Ct. decided where owner used due precaution to keep well properly covered and latter removed by stranger, owner not liable for death of child who fell in. *Case*—Granfield *v.* Hammonds (100 Okla. 75, 227 Pac. 140): In Okla., well on private land at considerable distance from pub. road. Work in progress, well left loosely covered by boards. Uninvited parents visited premises. Their wandering child fell in and drowned. Okla. Supreme Ct. held neither landowner nor contractor liable. *Case*—Gillespie *v.* McGowan (100 Pa. 144): In Pa., Supreme Ct. decided owner of uninclosed premises on which formerly brickyard operated, not liable for injury to youth who fell into old open well. Although defendants in last 3 cases successfully defended suits, fact remains 3 lives lost by insufficiently covered open wells and cost defendants vastly more to escape liability than it would have to cover

wells securely and to prevent accidents. *A Well That Was Not Completed. Ibid.* **16:** 11: 14 (Nov. '42). After drilling, 940′ hole left. Satisfactory down to 400′ level, where water-bearing gravel struck. As artesian flow desired, drilling continued. Unsatisfactory below that level, being clogged with broken casing, sand, gravel, lost cable and tools. Calif. Dist. Ct. of Appeals decided driller not entitled to compensation for part below 400′. Above that, clear from evidence that owner accepted job as 400′ well. Complex details of contract given with comments. *Case*—Orr *v.* Forde (101 Cal. App. 694, 282 Pac. 429). *Waiving Contract Performance. Ibid.* **16:** 12: 16 (Dec. '42). Even though well driller fails to comply with some agreed condition, landowner not permitted to take advantage of fact, once he has paid for well or done anything else to indicate acceptance thereof as conforming to contract requirements, as recognized by Wis. Supreme Ct. in case of Keller *v.* Oberreich (30 Northwestern Reporter 524). Also decided that money advanced to driller by owner, in reasonable expectation that contract will be fully performed, recoverable if owner shows driller failed in performance. Also recognized by ct. that driller bound by any agreement entered into to effect that proposed well is to be as good as another well considered by parties to agreement as a "sample." Details and comments given.—*Ralph E. Noble.*

Peculiarities of Law of Pollution. Leo T. Parker. Sew. Wks. Eng. **13:** 570 (Nov. '42). Outcome of majority of suits against munics. hinge on unusual rather than usual or commonplace law. *Right to pollute water limited by rights of others:* Various higher cts. held right of riparian owner to enjoyment of stream in its natural flow, quant. and qual., fundamental principle of law. Every riparian owner bound to use this common right so as *not* to interfere with its equally beneficial enjoyment by others. Ct. jurisdiction, therefore, rests on necessity of granting relief to prevent permanent injury or prevent vexatious litigation and multiplicity of suits. *See* Baltimore *v.* Appold, 42 Md. 442; Neubauer *v.* Overlea, 120 A. 69; Caretti *v.* Broring Co., 132 A. 619, 46 A.L.R. 1. Modern higher cts. recognize all running streams, to certain extent, pold., especially when flow through populous regions and waters used for mech. and mfg. Any use materially fouling and adulterating water, however, or deposit or discharge therein of filthy, noxious substance impairing water value for ordinary purposes, violates rights of lower riparian proprietor entitling him to recover damages from pollutor. Presiding cts., therefore, hold anything, person, firm or corp. rendering water less wholesome than in ordinary natural state, offensive to taste or smell, or disgusting to users of water for ordinary purposes *constitutes nuisance.* When 2 or more persons concurrently pollute stream, jointly and severally liable and subject to suit at injured party's option against one or all. *See* McDaniel *v.* Cherryvale, 91 Kan. 40. Thus insufficient to say others also commiting similar acts along same stream, as each liable to separate action and restraint. *All offenders held liable:* Riparian proprietor may maint. suit against several upper proprietors to restrain them from polg. stream with refuse, creating nuisance with injurious result even though defendants acting independently. *See* Jessup and Moore Paper Co. *v.* Zeitler, 24 Atl. (2d) 788, Md. (Apr. '42); Woodyear *v.* Schaefer; 57 Md. 1; Woodruff *v.* North Bloomfield Mining Co., 16 F. 25, 33; U.S. *v.* Luce, C.C. 141 F. 385, 411.—*Ralph E. Noble.*

Public Waters Pollution. *Orders for Installation of Sewage Treatments.* Charles D. Howard. N.H. Health News **19:** 9 (Nov. '41). Orders issued by the N.H. State Bd. of Health tantamount to requiring installation of sewage treatment plants by city of Rochester and town of Derry. Sewage and industrial wastes from Rochester discharge into Cocheco R. resulting in gross poln. of stream in its course through city. Town of Derry has no public sewer system, and Board's order deemed justified: (1) because of existence within Derry Depot section of numerous nuisance conditions; (2) because of gross overloading of small stream into which greater part of sewage of village discharges, with attendant numerous and long-standing complaints; (3) because of hazard imposed upon purity of town's water system, latter derived from wells situated along brook close to prin. sewage discharges.—*P.H.E.A.*

Sewage Disposal, Pollution of Watercourse on Private Property, Liability of City. *Dohany* v. *City of Birmingham* (*Mich.*) *et al.*, 2 N.W. (2d) 907 (Mar. 17, '42). U.S. Pub. Health Rpts. **57:** 1437 (Sept. 11, '42). Outside city limits, plaintiff owned land traversed by meandering, natural watercourse with channel

and well defined banks. At times dry, but heavy rainfall made stream outlet for raw sewage discharged from city sewer. City admitted condition existed at times, but asserted within right as riparian owner. State supreme ct. held city not such owner as no part of natural watercourse within city corporate limits; that no pub. necessity warranted city to injure rights of riparian owners by polg. stream; such right protected by Constitution and removable only by due legal process; plaintiff's right to abatement of nuisance not dependent upon water use for drinking or domestic purposes, but on fact land value materially lessened by sewage discharged across with attendant bad odors and visible human excrement. Ct. permanently enjoined defendant from violation described.—*Ralph E. Noble.*

Hard Clams—Prohibition of Digging in Certain Waters. (*N. Y. Supreme Ct.;* Matter of DeRoche; *decided '42*). Pub. Health Rpts. **57:** 1557 (Oct. 9, '42). Believed first ct. decision recognizing coliform scoring of waters as criterion of shellfish safety. In Mar. '42, N.Y. State Conservation Com. by order, and N.Y. City Bd. of Health by resolution prohibited digging hard clams in Raritan Bay. By statute authority vested in: (1) Conservation Com. to certify lands from which shellfish taken for food use, and (2) Bd. of Health to regulate all matters affecting city health, petitioner sought rescindment of order and resolution and direction of com. and bd. to: (1) reopen bay for clam digging, (2) not enforce order and resolution, and (3) fix and det. on scientific, fair, accurate and resonable basic std. of purity and san. condition for hard clams taken or sold and for waters overlying same. Com.'s or bd.'s power to act not challenged, but contended their action treating scientific subject unscientifically, and, as result, arbitrary, capricious, unreasonable and, consequently, illegal. Returns filed by com. and bd. showed waters available for hard clam removal Jan. 1, '40, and continued until above order and resolution made. When waters opened to clam indus., 2 respondents made tests and drew conclusions based on safety stds. accepted by various authorities then vested with control. In making tests, respondents collaborated with bacteriologist affiliated with business men interested in clam indus. and, then (autumn, '39), unanimous opinion was "where tested waters showed 70 coliforms per 100 ml., that deg. of poln. indicated absence of pathogenic organisms or at least condition assumed with safety." Later, upon unaccountable rise in coliform scores in bay, N.Y., N.J. and N.Y. City authorities requested U.S.P.H.S. investigation of Raritan Bay waters in relation to harvesting hard clams therein for human consumption. N.Y. Supreme ct. examd. U.S.P.H.S. report and said it "reveals carefully prepd. document, reflecting most deliberate planned action wherein utmost care exercised in making tests and performing expts. to end that accurate, fair, convincing result would be obtained. Report shows bay waters dangerously pold. with sewage exposing pub. to typhoid fever." This report, with expts., tests and reports by respondents, formed basis for prohibitory action attacked by petitioner. Latter argued report failed to show single contamd. clam taken from bay, but, in ct's. view, criticism unimpressive. Upholding respondents action, ct. stated in part: "Presence of pold. waters sufficient. Authorities should not wait until contamn. becomes real. Only point before ct. whether respondents acted arbitrarily, capriciously or unreasonably as charged. Respondents acted. Law authorized acts. Their competence unquestioned. They decided after investigation and careful consideration. In their return, set forth information sources prompting act. Sources found unassailable. On merits, ct. approves prohibitory action, but, if not, on showing presented, would be unwarranted in substituting judgment for that of admin. authorities charged with responsibility."—*Ralph E. Noble.*

New Law of Nuisances. Leo T. Parker. Sew. Wks. Eng. **13:** 455 (Sept. '42). Modern higher courts established new law that all persons, firms and munic. corps. whose enterprise harmful to pub. may be dealt with directly as nuisance, although facilities offered, while contrary to pub. policy or injurious to community welfare, do not constitute open crime. Among other examples, author cites *Dam is Legal Nuisance.* Well established law that owner's right to require lower one to receive surface water naturally draining on his property, incident to higher tenement and part of property of owner in it. Extent of servitude limited, i.e., civil law rules requiring lower landowner to receive surface water from higher prevail, and lower owner can obstruct flow. Any and all obstruction to natural drainage legal nuisance. In *McCoy* v. *Rankin* (42 N.E. (2nd) 234, (Jan. '42)), corp. con-

structed 4′ dam, thus obstructing natural flow, raising and maintg. water level at higher el. than in natural state on upland whose owner sued. Ct. held defendant's action (legal) may be maintd. without showing actual damage. Re underground streams, complainant may recover damages for alleged water diversion only if actual diversion proved. In *City of Atlanta* v. *Hudgins* (19 S.E. (2nd) 508 (Mar. '42)) property owner sued for damages, testifying water in underground stream diverted when city constructed trunk sewer through property. Ct. said owner of land through which non-navigable water courses flow entitled to have water in such stream come to his land in its natural flow subject to detention and diminution by reasonable use by riparian proprietors, but can make *no* complaint because landowner disturbs subterranean water entering stream thereby causing stream to cease flow.—*Ralph E. Noble.*

Illinois Water Litigation, 1940–1941. LANGDON PEARSE. Proc. A.S.C.E. **68:** 1689 (Dec. '42). Interest aroused by petition of State, Jan. 11, '40, for temporary relaxation of diversion order, restricting flow of water from lake Michigan to relieve condition existing in upper Illinois Waterway, particularly at Joliet. Litigation somewhat unique in that it involved the question: "When is poln. a menace to health," rather than well-defined problem of abatement of nuisance. Curiously, attorneys on both sides admitted that no cases could be cited as legal precedent. F. W. Mohlman and writer testified that, in absence of sludge deposits, at least 1 ppm. dissolved oxygen necessary to prevent nuisance. Eng. witnesses on both sides agreed that sludge deposits potent in their avid demand for oxygen and are most important factor in production of foul condition in Main Channel and Brandon Pool. Opposing states maintained that evidence falls far short of establishing menace to health and, at most, shows only annoyance, discomfort and inconveniences suffered by some people. No water from waterway used for drinking purposes. No swimming in it. All complaints based on offensive odors and effects ascribed to them. Evidence offered showing that Chicago per capita water consumption 214% more than avg. of 19 other Am. cities. Of 412,228 water services in Chicago, in '40, only 115,025 metered. Illinois offered evidence showing that to provide universal metering would require 300,000 meters, costing in excess of $10,000,000 and 6 yr. to install. On basis of conclusions Master recommended dismissal of petition and taxing costs of litigation against State.—*H. E. Babbitt.*

Legal Notes and Comment—Washington. *Purchase of Land by City for Water System; No Budget Item; Constitutional Debt Limit.* JOHN A. HOMER. Western City **18:** 9: 62 (Sept. '42). Third class city desires to purchase land valuable to city water supply for $3000, with down payment of $500, bal. in annual installments. Contract provides for city cancellation, forfeiture of prior payments but not further liability. Surplus in water fund for down payment, but item not included in budget. Council cannot vote emergency appropriation because not unanimous on proposal. Question, how to consummate transaction in view of constitutional debt limit in amt. exceeding 1½% of taxable property without ⅗ of of voters assenting. Lease agreement with annual payments and option to purchase might avoid constitutional inhibition. *See* Friese *v.* Edmonds, 158 Wash. 316. In such agreement, annual payment should not exceed debt limit. Re: budget, doubtful whether city can agree to purchase property and provide payment without including items and down payment therein. Of course, unanimous council vote would authorize emergency payments. *See* State *ex rel* Henderson *v.* Mt. Vernon, 172 Wash. 414. Also doubtful whether acquisition of land could be considered mandatory govt. expenditure which apparently may be made without budget or constitutional debt limitation provisions. *See* Goff *v.* Seattle, 197 Wash. 665. In case of McCarthy *v.* Kelso, 129 Wash. 121, ct. approved mandatory govt. expenditure to preserve purity and healthfulness of city water supply, on theory that the contamd. water menaced pub. health. Surplus funds available for down payment does not excuse noncompliance with budget law. *Budget law; emergency item; tax levy for repayments:* Town desires to dig new well to supplement water supply, but expenditure not included in annual budget. Surplus funds available. Council would like to pay, but fears if done with emergency warrants, levy through next budget required. Provision seems intended for cases where funds used for payment of warwants from improper appropriations.—*Ralph E. Noble.*

Legal Notes and Comment—California. *Torts: Munic. Liability Act of 1923: Storm Drainage System.* ANON. Western City **18:** 10: 50 (Oct. '42). Action for damages to residential property from landslides. Defendant city constrd. storm water drainage system for water falling in watershed, where plaintiff's property located. City admitted damage caused by negligent constr. and maint. of part of drainage system. Ct. held in plaintiff's favor under provisions of '23 liability act. *See* Gove *v.* Lakeshore Homes Assn., 54 A.C.A. 205 (August 26, 1942).—*Ralph E. Noble.*

CORROSION AND CORROSION CONTROL

The Quality of Water Supplies and Conservation of Materials. L. W. HAASE. Gesundh. Ing. (Ger.) **65:** 17 ('42). Deals with compn. of various types of water supplies and their effects on materials used in constr. of water pipes, etc. True ground waters in contact with soil for some time are in equilibrium with soluble salts in soil and usually contain larger quants. of soluble salts than do surface waters. Age of ground waters can be detd. from contents of dissolved oxygen, free carbon dioxide and hydrogen sulfide. Shallow ground waters, bank-filtered surface waters and artificial ground waters contain more org. matter; and nitrogen compds. chiefly in form of nitrates or nitrites. With true ground waters, damage to materials in water works prevented if iron, manganese, carbon dioxide and hydrogen sulfide removed. With artificial ground water, org. matter must also be removed, as it is harmful in itself and reduces content of dissolved oxygen. Increasing poln. of streams, particularly by trade waste waters, increases danger of lowering quality of artificial ground water. Surface waters not in equilibrium and frequently contain aggressive materials or materials which make treatment difficult. Use of disinfectants such as chlorine frequently necessary and these may damage materials by increasing aggressive action of water. Recently, pure hypochlorites prepd. free from hydrochloric acid and free chlorine; these will not cause corrosion. Great variety of org. materials found in surface waters. Organisms develop in summer months and, when they die and decay, reduce content of dissolved oxygen and increase content of carbonic acid; this leads to increased soln. of minerals and to increases in the content of iron and manganese compds. Now realized that org. iron and manganese compds. more often cause of damage to pipes than carbonic acid, as they form slimy coatings which prevent access of oxygen to the walls of pipes. Qual. of surface water improves when stored in reservoirs and life of materials with which it comes in contact increased. Co-operation between different users of water required to improve qual. of water supplies and to obtain max. length of life for materials with which water comes in contact.—*W.P.R.*

Water Purification in the Service of the Four-Year Plan. K. ULRICH. Gesundh. Ing. (Ger.) **62:** 713, 729 ('39). Estd. that losses due to corrosion in Germany amt to 1–2 milliards RM. per year. Considerable corrosion occurs in heating and hot-water plants. Formation of scale also causes trouble in hot-water and heating plants. Causes of corrosion and of scale formation outlined. Corrosion due to presence of oxygen or of CO_2 can be reduced by the use of resistant materials such as copper. This metal, however, nearly all imported into Germany and must be used sparingly. Iron with low content of carbon, iron alloys, aluminum, porcelain, glass and synthetic resins tried. Corrosion less in l-p. than in h-p. plants, as corrosive gases more soluble at higher pressures. Various methods used to reduce corrosion and scale formation by modifying design of plants. Marble, calcium hydroxide or magnomasse may be used for removing aggressive CO_2 from cold water. In hot-water systems, two main methods for prevention of corrosion—removal of oxygen and formation of protective layer on metal. Oxygen may be removed by addn. of sodium sulfite, and apparatus designed for adding this chem. automatically as required. In Rostex filter, oxygen removed by manganese-iron filings, but eff. diminishes with use. In "K-C-S" process, sodium phosphate added to form protective layer of double phosphates of calcium and magnesium with iron zinc. Electrolytic protection also used; an aluminum electrode forms positive pole and wall of tank, negative pole. Hydrogen produced reacts with dissolved oxygen and so reduces corrosion throughout system. During last few years, Magno process also used for treating hot water. In "Sterosol" process, mixt. of tannic acid salts, sodium sulfite,

and various inorg. constituents added to water. Tannic acid salts coagulate scale-forming compds. and produce protective slime over walls. By means of "Tonisator" process, claimed that crystalline form of carbonate deposited changed so that hard scale not formed. For protection of central heating plants, chromate and phosphate processes used. In chromate process, dil. soln. of chromic acid added to water. Calcium and magnesium carbonates and bicarbonates converted to soluble chromium salts. Iron-chromium compd., resistant to action of oxygen, formed on walls. Process not suitable for treating water with high content of non-carbonate hardness. When phosphates used in l-p. systems disodium phosphate preferred to trisodium phosphate, which is used for h-p. boilers. Dicalcium and dimagnesium phosphates are pptd. To remove calcium sulfate scale, chromic acid may be added, followed by sodium phosphate.—*W.P.R.*

Corrosion of Buried Metals. J. C. Hudson, T. A. Banfield & H. A. Holden. Engineering (Br.) **154:** 124 (Aug. 14, '42). Little systematic work in this field undertaken in Great Britain. Tests on buried specimens of iron and steel undertaken, with collaboration of Mid-Wessex Water Co., in neighborhood of Binfield. Object to ascertain how far conditions of exposure affect exptl. results and thus avoid gross errors with more extensive exptl. program. Effects of different depths of soil cover, orientation of specimens and proximity of dissimilar metals studied. Examn. of soil samples made at conclusion of tests. 95 specimens exposed—86 iron or steel and 9 zinc. After exposure, specimens brushed, scrubbed and immersed in pickling bath, inhibitor present preventing any appreciable loss of metal. Rate of hydrogen evolution measured and amt. of metal dissolved calcd. from this. Location and depth of pits noted and measured. Pits less than 10 mils (0.010″) deep not measured. Avg. loss in weight of specimens of ingot iron, vertically cast iron and sand-cast iron 1.5 mils annually. Deepest pits observed on any one specimen after 3 yr: vertically cast iron, 44 mils; sand-cast iron, 78 mils; and ingot iron, 58 mils. Rolling scale protected specimens appreciably. Avg. pitting greater for vertical specimens than for horizontal ones. Signif. decrease in pitting for increasing depth of burial. In method, change in elec. resistance of metallic specimens successfully applied to study of atmospheric corrosion of non-ferrous metals. Method adopted consisted of burying helix of mild-steel wire in soil and corroding it artificially by electrolysis. At end of expt., loss in weight calcd. from total by Faraday's law. Concluded that possible to follow change in elec. resistance of specimens buried in soil and that change reasonably good indication of extent to which they have corroded.—*H.E. Babbitt.*

The Corrosion of Iron Pipes. Anon. Science—Suppl. **96:** 10 (Oct. 2, '42). Bacteria responsible for corrosion in iron pipes carrying deep well waters in Miami Valley, Ohio. Waters contain little O_2 or other corrosive agents chemically detectable. Similar trouble with "red water" at Middletown, Ohio, cleared up by chlorine treatment killing bacteria. Anaerobic cocco bacillus chiefly responsible. Reduces sulfates liberating H_2S which attacks Fe forming black FeS. "Iron-consuming" crenothrix, spirophyllum and leptothrix, also present, convert dissolved ferrous salts to insoluble red ferric oxide (Fe_2O_3) producing "red water." Oxygenation decreased corrosion as O_2 content increased. Remedy is to chlorinate. If chlorine tastes objectionable, ammonia-chlorine treatment recommended. Not only kills bacteria but removes deposits. Ordinary lime-soda softening treatment not entirely bactericidal. Coal-tar base enamel coating will protect metal.—*Ralph E. Noble.*

Role of Bacteria in Corrosion. Arba H. Thomas. W.W. & Sew. **89:** 9: 367 (Sept. '42). Several instances of severe corrosion observed with water which should have been non-corrosive when measured by ordinary mineral anals. and by Langelier index. By means of controlled lab. studies, found that water relatively low in D.O. and contg. chlamydobacteriaceae (crenothrix, spirophyllum and leptothrix) and cocco-bacilli most corrosive. When such organisms destroyed, either with chlorine residuals of 0.5 ppm., chloramines or, to lesser extent, by lime-soda softening, corrosion stopped. Since these organisms probably facultative anaerobes, increasing D.O. reduces amt. of corrosion. Appears then that to prevent such corrosion in absence of sterilizing agents, D.O. must be maintd. in all parts of distr. system. If neither water treatment nor maint. of D.O. possible, good coal-tar enamel coating advisable.—*F. J. Maier.*

Distribution and Attack on Iron or Zinc Partly Immersed in Chloride Solutions. ULICK R. EVANS. Nature. **150:** 151 (Aug. 1, '42). Fe or Zn partly immersed in NaCl or KCl at first remains unattacked at water-line. Corrosion occurs at zone somewhat below, apparently connected with elec. current flowing between this zone as anode and cathodic zone at water-line where O_2, cathodic stimulator, most easily renewed. Corrosion rate approx. equiv., in sense of Faraday's law, to this current, which, for solns. of high conductivity, may approach limiting value given by intersection of anodic and cathodic polarization curves; for less conducting liqs., is value i, which will make and intercept iR, where R = resistance. Thus, short-period phenomena cleared up. Long-period corrosion studies of Bengough and Wormwell show finally both metals more attacked at water-line than elsewhere. Violent attack at zone previously immune suggests corrosion mechanism in later stages different from that in early ones; but introducing essential distinction between probability and conditional veloc., common explanation appears for seemingly divergent facts. Author augments explanation with analytical formula, illustrating changes in variables under different conditions. Zn more liable to attack at water-line than Fe, while wetting specimen above same increases chance of breakdown.—*Ralph E. Noble.*

Corrosion of Steel by Dissolved Carbon Dioxide and Oxygen. G. T. SKAPERDAS & H. H. UHLIG. Ind. Eng. Chem. **34:** 749 (Aug. '42). Unexpected corrosion difficulties in parts of condensate return lines of central steam-heating systems initiated study on effects of temp., dissolved CO_2 and O_2, pH, circulation of corroding medium, metal compn., duration of attack and relative activity of CO_2 and O_2. Expts. carried out under controlled conditions in thermostatically regulated glass reservoir arranged for introduction of gases as desired. Small steel specimens suspended from cover plate and corrosion losses checked by weighing. Expts. made at 60° and 90°C. Solns. at 60°C. contg. O_2 cause 6 to 10 times as much corrosion as CO_2 in same molar concns., comparative effect of CO_2 being greater at low gas concns. At 90°C., increase in corrosiveness of CO_2 relatively greater than that for O_2. Corrosion by soln. contg. both CO_2 and O_2 is 10 to 40% higher than sum of corrosion by two gases acting separately. Appears related to nature of corrosion products. Raising temp. from 60° to 90°C. multiplies corrosion by O_2 by 2.1 and by CO_2 by 2.6. Mixt. of two has intermediate temp. coef. Corrosion rate apparently largely controlled by diffusion of gases to metal surface. Unlike case for O_2, when corrosion largely by CO_2, apparently structure and compn. of steel are factors in detg. its life.—*Selma Gottlieb.*

Protective Coatings for Steel. ANON. [CHARLES H. ELLABY.] The Engr. (Br.) **174:** 122 (Aug. 7, '42). Study of protective coatings for steel surfaces subjected to both water and atmospheric exposure made by U.S. Engr. Dept. Research pointed toward synthetic resin vehicle paints and narrowed down to 100% phenol-formaldehyde resin in combination with china wood oil as vehicle. Coating resistant to relatively severe phys. stresses necessary to withstand driftwood churning and revolving at high speed almost continuously against steel, creating severe abrasion. Only one pigment—zinc chromate—possessed ability for chem. inhibition of rust. Sand imbedded in fresh wet priming coat and covered with two finish coats to provide addnl. wear factor. Became apparent that no sepn. of films between multiple coats where undercoat contained aluminum pigment. Regardless of materials used, desirable to maint. same or similar color in all paint films on given area. Summary of procedure consists of: (1) complete removal of mill scale either by acid pickling or sand blasting; (2) inhibitive treatment of cleaned surfaces with phosphoric acid-sodium dichromate soln.; and (3) application of at least 3 coats of synthetic phenol resinol-tung oil varnish, vehicle paint, pigmented to suit existing conditions.—*H. E. Babbitt.*

Influence of the pH of a Solution on the Corrosion and Electrode Potential of Copper. G. V. AKIMOV & I. L. ROSENFELD. Zhur. Fizich. Khim. (U.S.S.R.) **14:** 1486 ('40). In aq. solns. of varied pH (HCl and NaOH, with and without 0.01N-NaCl), electrode potential of copper displaced toward negative values with decrease of pH between 3 and 0. Can be explained by: (1) high concn. of Cl ion; (2) destruction of protective film of Cu_2O by Cl ion; and (3) possible formation of simple and complex compds., latter causing also considerable corrosion of the copper. In range pH 3–10, copper has more positive electrode

potential and undergoes insignif. corrosion, owing to stability of protective film and formation of electrodes of second kind. In the range pH 10–14, potential again displaced towards negative values and corrosion increased as result of soln. of protective film with formation of cuprites Na_2CuO_2 and $NaHCuO_2$. Max. of potential-pH curve does not coincide with that of corrosion-pH curve. —*I.M.*

Corrosion Tests of Soldered Joints on Copper Tubes. A. W. TRACY. Heatg., Piping & Air-Condg. **14:** 538 (Sept. '42). Values of breaking load in pounds for type L hard Cu tube soldered joint assemblies reported. 5 different solders tested, using plain tap water and same acidified with CO_2. Tests confirmed practical experience that Cu tubes assembled with soldered fittings give excellent service for conducting domestic water supplies and for hot-water heating lines. Showed corrosion of soldered joints not appreciable even at pH 6.0 after 6-yr. continuous test. Cu tubes and wrought Cu or cast-brass fittings available only on WPB allocation. With unlimited possibilities for growth of this type of piping installation after war, however, study valuable to engrs. and contractors.—*Ralph E. Noble.*

Corrosion of Copper-Alloy Condenser Tubes by Water. JAMES T. KEMP. Proc. Am. Petrol. Inst. **22:** (III): 56 ('41). Illustrated account given of various forms of corrosion which may occur on water side of condenser tubes in oil refineries, with special reference to their visible effects. Include uniform or localized thinning of tube wall, dezincification with redeposited copper, chem. attack, selective corrosion (as of β constituent in Muntz metal), grain-boundary attack, corrosion cracking and erosion.—*I.M.*

Investigating the Corrosion of Lead in an Oxidizing Medium. E. V. KRIVOLAPOVA & B. N. KABANOV. Zhur. Priklad. Khimii (U.S.S.R.) **14:** 335 ('41). Cast disc of lead scraped immediately before expt. with sharp chisel, so as to clean entire surface. A 6.7N soln. of H_2SO_4 used as electrolyte. Electrode of pure lead placed on either side of sample under test, at distance of about 2.5 cm. Potential measured against auxiliary electrode $Hg|Hg_2SO_4,H_2SO_4(6.7N)$, at room temp. Polarization curves for oxidation of electrodes of pure lead and of lead contg. 8% antimony, polarization reduction curves for electrodes of pure lead in N Na_2SO_4, and of lead electrodes with admixture of antimony in 2N Na_2SO_4, pre-oxidized at a cd. of 0.2 ma. per sq.cm., plotted. Polarization curves also prepd. of reduction of electrodes from pure lead and of lead with admixture of antimony in 6.7N H_2SO_4, oxidized at a cd. of 10.0 ma. per sq.cm. Effect on polarization curves of following substances added to electrolyte during reduction of electrodes of pure lead oxidized in presence of these substances investigated: stearic acid, HCl, acetic acid, caprylic acid, K_2CrO_4, H_2SO_4, palmitic acid, HNO_3, and $CoSO_4$. Addn. of HCl, acetic, palmitic, caprylic or stearic acids promotes lead corrosion; cobalt inhibits it.—*C.A.*

Corrosion of Light Alloys by Tap Water. ANON. Light Metals (Br.) **5:** 53: 190 ('42). Summary of work of Mialki and Popper (Aluminium (Br.) **23:** 583 ('41)), who studied corrosion of pure aluminum and of Aludur in hot and cold tap water. Sheet specimens tested as received, as lacquered, as anodized, or as anodized and lacquered. Effect of satg. tap water with O or with CO_2 and of allowing it to pass over heavy metals (copper, lead or iron) investigated. Extent of corrosion estd. by visual examn. and from deterioration in mech. properties. Detailed descriptions of specimens given.—*I.M.*

Corrosion Behavior of Aluminum and Aluminum Alloys Toward Aqueous Solutions at Various Temperatures. H. U. VON VOGEL. Korrosion u. Metall. (Ger.) **16:** 259 ('40). Results recorded of more than 2000 corrosion tests in various acid, alk. and neutral salt solns. on 3 grades of aluminum (99.5, 99.8 and 99.99%), Mangal, Silumin, Pantal, KS Seewasser alloy and BS Seewasser alloy; tests also made on Mangal, Pantal and 99.5% aluminum clad on both sides with 5% of 99.99% aluminum. Results shown in 17 tables and series of graphs. In all cases where corrosion appreciable, considerably accelerated by rise in temp., except when protective films formed. In acid solns. of pH less than 3.5, corrosion severe with all materials tested; in less strongly acid solns., purest aluminum most resistant; then followed alloys in order given above, magnesium-contg. BS alloy being most strongly corroded. In alk. solns., alloys contg. magnesium more resistant than those free from this metal, since former tended to develop protective films with high

magnesia content. When pH exceeded 10, however, all alloys corroded rapidly and no protective films formed.—*I.M.*

A Case of Damage to Aluminum by Paint Pigments. L. RESCHKE. Korrosion u. Metall. (Ger.) **16**: 254 ('40). Aluminum panel painted in red and black with emblematic design on white background of lithopone varnish showed signs of deterioration very shortly after installation and a little later large areas of red paint flaked off, leaving badly corroded aluminum below. Cause of trouble traced to use of cinnabar as red pigment; this decomposed on exposure to light, giving free mercury which penetrated porous places in lithopone varnish undercoat and moisture of air then attacked resulting mercury-aluminum couple in well-known way. Use of mercurial and lead red pigments on aluminum should be avoided; all other known red pigments have no action on aluminum.—*I.M.*

Methods of Cleaning Corrosion Coupons. C. E. LEE & A. C. ALTER. Petrol. Engr. **13**: 10: 92 ('42). Chem. *vs.* cathodic methods for removing rust and scale from steel coupons used for predicting rate of corrosion of pipelines compared. Tests carried out using 2% aq. soln. of NH_4 citrate at 212°F., electrolyte comprising 2% aq. soln. of H_2SO_4 (pH = 0.6) at room temp. and cd. of 0.024 amp. per sq.in., or Na_2CO_3-NaOH electrolyte (pH = 12.6 to 13.2) at 180°F. and 0.139 to 0.416 amp. per sq.in. indicate that cathodic cleaning to be preferred since it produces less change in wt. of metal, effectively removes corrosion products and is easily controlled. Graphs show that increasing concn. from 0–3% greatly increases wt. loss of metal in case of NH_4 citrate but does not affect it in case of electrolytes. Increasing cleaning time to 60 min. does not affect metal loss in cathodic cleaning, but increases it almost linearly in NH_4 citrate cleaning. A cd. of not less than 0.1 amp. per sq.in. prevents loss of metal in H_2SO_4 electrolyte, but in alk. electrolyte "small but insignificant" gain in wt. is experienced at all cd. values.—*C.A.*

Corrosion and Paint. GEO. DIEHLMAN. Paint Varnish Production Mfr. **22**: 3 ('42). Ordinary corrosion of Fe or steel is electrochem. Metal surfaces can be conditioned for reception of paint by wire-brushing, sandblasting, pickling, chem. and electrochem. treatments followed by deposition of CrFe phosphate, Fe chromates, oxides, etc., shotblasting and flame-cleaning. Linseed oil possesses best surface-wetting characteristics of commonly used paint vehicles. Red lead functions as corrosion inhibitor by developing and maintg. alk. environment at metal-paint film interface and also inhibitive because of particular oxidizing qual. Presence of Pb soaps in oxidized paint film imparts greater impermeability to moisture. Red lead paint primers formulated with suitable vehicles used not only for metal surfaces subjected to atm. exposure but also for underwater service and exposure to acid and alk. environments. Photomicrographs included showing needle structure of particles of Pb soap which radiate in fan shape from particles of red lead immersed in raw linseed oil.—*C.A.*

Protection of Pipes by De-acidification of Drinking Water. H. HAUPT. Gesundh. Ing. (Ger.) **64**: 333 ('41). Discusses mechanism of corrosion of iron and lead pipes by waters contg. free carbonic acid. Aim of treatment should be not only removal of aggressive CO_2, but also formation of protective layer on metal. When corrosion occurs, content of iron in water increased; undesirable for many purposes. Corrosion may also occur in absence of aggressive CO_2 if dissolved oxygen present. Various methods of de-acidification discussed. When large quants. of free CO_2 and ferrous bicarbonate to be removed, aeration suitable process, but does not always reduce concn. to sufficiently low level. By filtration through marble, free CO_2 combines with calcium carbonate to form calcium bicarbonate. Period of contact of at least 40 min. necessary. Process not suitable if water contains much colloidal or suspended matter, as surface of marble becomes covered. Treatment with lime water widely used at large water works. Process can be regulated to give any desired deg. of treatment. Increase in hardness only about half that caused by filtration through marble, but, with very acid waters, may be greater than desirable, in which case preliminary de-acidification by aeration should be carried out. Magnomasse consists of calcium carbonate and magnesia in equal quants. In contact with CO_2, magnesium carbonate and calcium carbonate formed. Calcium carbonate less soluble than magnesium carbonate; therefore pptd. in preference when both present. This important in formation of protective films. Magnomasse will also remove iron and manganese.—*W.P.R.*

Tube Corrosion Held to a Minimum by Continuous Check on Dehydrator Water pH. J. L. PFAU & H. A. BLACKSTONE. Refiner Natural Gasoline Mfr. **21:** 16 ('42). Continuous, stoutly constructed pH recorder of glass electrode, reference electrode and resistance thermometer for automatic temp. compensation used to hold waste water steadily at values between 7.5 and 8.0 pH.—*C.A.*

Chromate Corrosion Inhibitors in Bimetallic Systems. M. DARRIN. Ind. Eng. Chem.—Anal. Ed. **13:** 755 ('41). When examg. corrosion in bimetallic systems, changes in weight do not give clear indication of course of corrosion. Method of evaln. of corrosion based on visual examn. of specimen and corroding liquid described. Varying numbers of points given to characteristics such as discoloration, roughening and pitting of metal, and production of cloudiness or ppts. in liquid. Method used in detg. inhibition of corrosion in bimetallic systems by sodium chromate and bichromate. Effect of these inhibitors on corrosion of various combinations of metals in tap water from Baltimore examd. at room temp. and at higher temps. Sodium chromate retarded or completely inhibited corrosion of many bimetallic systems in water. Sodium bichromate also reduced corrosion in many cases, but less generally effective than sodium chromate. Corrosion more rapid at higher temps. but relative deg. of inhibition same as in cold water. Varying concn. of chromate had little effect on results, but amts. of less than about 100 ppm. should not be used for systems contg. iron. In one series of tests pH value of alk. sodium chromate soln. adjusted to 7 by addn. of sodium bichromate, keeping total concn. of chromium same; little effect observed, but, if anything, slightly better protection afforded when pH not adjusted. When sodium chromate present, aeration did not increase corrosion. In practical trials with air-conditioning units addn. of chromate not only prevented corrosion, but also prevented formation of org. slimes.—*W.P.R.*

Haering Announces New Corrosion Inhibitor. ANON. Internatl. Eng. **81:** 291 (June '42). New non-oxidizing chromium inhibitor, ferric salt of quachromglucosate. In some applications, 2 ppm. concn. controls corrosion. May be used in reducing equilibria and at low pH values for same purpose. Being colloidal gel, usable for film formation in process operations by dipping, spraying or incorporation in paints or lubricants to control corrosion. Contains little Cr; non-irritating to handle. May reduce Cr consumption as much as 2 decimals.—*Ralph E. Noble.*

Prevention of Attack by Oxygen-Free Condensed Water Upon Ferrous Materials by Means of Ammonia. W. WESLY. Korrosion u. Metall. (Ger.) **18:** 158 ('42). In cold water, free of O_2 and CO_2, corrosion of Fe soon comes to stop owing to low acidity and presence of protective H_2 layer on Fe. At higher temps., such as those existing in h-p. boilers, dissocn. const. of water increases; this results in pH of 5.63 at 370°. Similar considerable shift results from small amts. of CO_2. For water contg. 200 mg. of CO_2 per l., pH of 4.43 computed. Corrosion also accelerated by flow of water which disturbs H_2 layer. By means of practical cases, shown that corrosion in h-p. installations can be diminished by making water weakly alk. by addn. of ammonia or ammonium salts to give pH of 9 at 23°.—*C.A.*

Recent Developments in the Use of Hexametaphosphate in Water Treatment. OWEN RICE. J.N.E.W.W.A. **56:** 84 (Mar. '42). Several hundred plants now using sodium hexametaphosphate for corrosion control with excellent results. Exptl. results with steel wool provide basis for plant recommendations. Tests showed: (1) corrosion decreased as concn. of metaphosphate in water increased; (2) presence of metaphosphate reversed normal condition causing decrease in corrosion with increasing rates of flow; (3) with film formed on steel at higher dosage, 0.5 ppm. will maint. film; (4) heavily rusted surface adsorbed more metaphosphate before protection achieved; (5) protective film reduces corrosion at all pH values above 3.5, but best above 5.0. Inhibition of corrosion due to adsorption of thin film of metaphosphate on metal. Addn. of min. of 1 ppm. metaphosphate for each 1 ppm. of Fe, added before chlorine or oxidation of Fe, will prevent pptn. of the Fe. Water will become yellow on prolonged standing, not objectionable if Fe content below 2–5 ppm. Addn. of 4 ppm. per ppm. Fe will prevent any discoloration. Results believed due to adsorption just as in corrosion prevention; not yet known whether oxidation of ferrous Fe or agglomeration and pptn. of hydrated ferric oxide prevented. Red water condition cured at Fairhaven, Mass. (*see* Jour. A.W.W.A. **32:** 1484 ('40)). At this plant disturbance of old main deposits occurred when treatment

started. This not usual and statement made that no softening of old corrosion products reported from any of plants using metaphosphate for corrosion control, but that dispersion of old deposits reported for each plant where material used to prevent pptn. of Fe from well water. At Winchester, Mass., with water of 20 ppm. hardness and pH 6.0–7.0, Fe content at dead ends decreased to 0 inside of 1 mo. Similar results obtained at Millbury, Mass. and Garden City, N.Y. (pH 4.9–5.6) (*see* Jour. A.W.W.A. **32:** 1498 ('40)). Examples cited of prevention of pptn. of Fe: Sumter, S.C. (Fe content 1 well, 3.8 ppm.), Canton, Ohio (Fe 1 well, 1.5), Jamaica, N.Y. (Fe 0.3–1.8). Control of tuberculation demonstrated by lab tests with black-iron pipe and head required to maint. const. flow. With Pittsburgh city water, feed of 1 ppm. metaphosphate reduced tuberculation 50% as measured by increase in head, 5 ppm. feed effected 80% reduction. Noted that, at low pH values, corrosion general and fairly uniform over entire surface of pipe; as pH increases corrosion becomes more and more localized and results in formation of fewer but larger individual tubercles. Metaphosphate reduces corrosion and tuberculation at both low and high pH values. To obtain optimum results in prevention of tuberculation, treatment at low pH (below 7.0) recommended. From experience, author recommends following min. metaphosphate feed—(a) vol. of flow and (b) concn. of metaphosphate: (1) (a) over 10 mgd., (b) 0.5 to 1 ppm.; (2) (a) to 10 mgd., (b) 1 ppm.; (3) (a) 0.5 to 1 mgd., (b) 2 ppm.; (4) (a) less than 0.5 mgd., (b) 4 ppm. These figures only rough averages; concn. of metaphosphate in extremities deciding factor—should be 0.2 to 0.5 ppm. *Discussion.* Edward W. Moore: Evidence accumulating of existence of substances, including metaphosphates and pyrophosphates, that mitigate corrosiveness of water without appreciably affecting its hardness, alky., CO_2 content or pH. Sloughing off of old deposits encountered in few cases where Mn or Fe in water deposited on pipe interior; flushing appears only remedy until deposits sloughed off. Because metaphosphate solns. used to remove spray residues from fruit, question raised as to action on lead pipe. Hatch reported (Jour. A.W.W.A., **33:** 1179 ('41)) metaphosphate minimizes corrosion of fresh metallic lead, Moore found opposite to be case in Cambridge (Mass.) water (results possibly due to different method of cleaning lead wool used). Problem in old pipe has to do with deposits of lead salts, basic lead carbonate, etc. Unfinished lab. expts. by Moore have so far shown nothing very alarming. Wherever increase in Pb pickup due to metaphosphate noted, increase seldom greater than 100%, even when Pb picked up by water with 0 metaphosphate small. On this basis, discusser states that it would seem that no very serious danger exists in application of metaphosphates to water systems contg. Pb pipes or services. This statement, however, merely opinion subject to alteration in light of further exptl. data (*see* Jour. A.W.W.A. **34:** 1807 ('42)).—*Martin E. Flentje.*

Cathodic Protection. R. H. Brown & R. B. Mears. Trans. Electrochem. Soc. **81:**—; *27-pp. preprint* ('42). If corrosion electrochem., may be concluded from this work that: In order that protection may be complete, potential of cathode areas must be polarized to potential equal to or more anodic than open-circuit potential of anodes. In solns. where cathodic polarization large compared with resistance drop, cathode must be polarized to open-circuit potential of anodes. In solns. where cathodic polarization small compared with resistance drop, cathode must be polarized to potential more anodic than open circuit potential of anodes. Current required for complete protection will depend upon current required to polarize cathode to potential equal to or more anodic than open-circuit potential of anode; will depend upon position of auxiliary anode relative to position of local anodes and cathodes. The lower the potential drop between auxiliary anode and local cathodes, the less the current required. Special attack or inhibition may be produced by products of electrolysis resulting from application of cathodic current. Special attack on surfaces which are made cathodic may be beneficial if type of attack also altered.—*C.A.*

Electrolytic Behavior of Ferrous and Nonferrous Metals in Soil-Corrosion Circuits. I. A. Denison. Trans. Electrochem. Soc. **81:** —; *10-pp. preprint* ('42). Measurements made on behavior of variety of metals exposed to corrosion in soils having widely different chem. and phys. properties. Metals studied were low-carbon steel, 2 varieties of stainless steel, Cu, low-Cu brass, Zn and Pb. Specially designed corrosion cell, previously used in studying corrosion of steel, employed. Current required to bring electrodes of cor-

rosion cell to same potential selected as measure of corrosion of steel and Zn and of other metals in certain environments. For all other materials and environments in which corrosion cell did not develop definite polarity, min. current required to protect cathode of cell from corrosion taken as equal to corrosion current. Rates of corrosion in lab. compared with results of long-time field tests. Electrode at which rate of corrosion controlled indicated for different materials and environments.—*C.A.*

Determination of Efficiency of a Cathodic Protection System. H. C. GEAR. Gas Age **88:** 13: 26 ('41). Cathodic-protection units located at 6000′ intervals along gas pipe. *IR* drops along 6000′ section detd. for each 100′ length of pipe, where I = current flowing in amp. and R = resistance in ohms per 100′. Reduction in corrosion by soil computed. Varied from 90%, where current density 10 ma. per sq.ft. of exposed pipe, to about 15% for cd. of 0.6 ma. per sq.ft. Latter condition is for pipe farthest from current drain.—*C.A.*

HYDRAULICS

Conformity Between Model and Prototype. *A Symposium.* Proc. A.S.C.E. **68:** 1268 (Oct. '42). *Hydraulic Structures.* JACOB E. WARNOCK & H. G. DEWEY JR: Reasons why so little progress made in comparing hydr. performance of model and prototype may be explained by lack of interest, particularly after prototype in satisfactory operation, natural reliance on model theory and difficulties of making prototype measurements. Since necessary to take nearly same measurements in field as in lab., instruments should be available for measuring discharge pressure on boundary surfaces, water-surface elevations and profiles, velocity, vibration, air-demand, bed movement and for photography. Frequently desirable to measure vibrations occurring at prototype structure, not necessarily to compare with model to establish relation but more to ascertain what effect vibrations may have on structure. Still and motion pictures of all flow conditions observed both in lab. and field invaluable for purposes of comparison. Qual. and quant. examples of model-prototype comparisons reaffirm high deg. to which model can be relied upon. *Dam Outlet Works in a Western State.* S. P. WING: Principal hydr. model tests of dam outlet works which included flow through intake tower, penstock turbine and outlet valve manifolds, made on $5\frac{5}{8}''$ (1 : 64 scale) extremely smooth, sheet-metal model which had friction coef. of $f = 0.021$ at Reynolds no., **R**, of 80,000 and used max. of 2 cfs. of water. Performance and eff. tests of 30′ diam. prototype, utilizing max. discharge of 20,000 cfs. with measured velocities up to 90 fps. and at **R** from 40 to 70 $\times 10^6$, made it possible to obtain data from which various hydr. features of model and prototype could be compared. Quant. correspondence between model and prototype can be expected only where Reynolds criteria can be satisfied and where absolute roughness in model can be scaled down in accordance with model laws. Believed that, on the whole, use of model for predicting quant. results in outlet works pre-eminently successful, nearly halving error in design that would have existed without it. Particularly required are methods for forecasting pipe friction in terms of quant. pipe roughness and for estg. fitting losses at various distances downstream in stretch before veloc. distr. has become normal. *Spillway Coefficients at an Eastern Dam.* G. H. HICKOX: Dam concrete gravity structure having total length of 1860′ and max. height, to roadway on top at el. 1061, of 265′. Spillway crest is at el. 1020 and is 399′ long, divided into three bays each 100′ long. Comparison shows that model tests can be relied on to predict prototype discharge coefs. with accuracy at least equal to that of stream-flow measurements. Avg. discrepancy of 3.9% not serious and certainly less than might be expected without benefit of model tests. *Pressure Heads on a Western Dam.* J. C. STEVENS & R. B. COCHRANE: Replica of 10′ length of crest and gate made to scale of 1 : 5 in flume, 2′ wide, 10′ deep and 10′ long. In prototype piers, there were two gate grooves; in one, gate seal was 9′ upstream from center-line of crest and in other, 8′ downstream. Pressure heads on model and prototype in fair agreement for gate in downstream position. For gate in upstream position, some interesting departures of prototype pressure heads from those of model. Explanation for discordant results undoubtedly lies in fact that, with gate in upstream position, tendency for jet to spring free from crest. Model consistently refused to show neg. pressures where such pressures should have obtained, just below crest. *Meter Measurement*

of Dam Discharge. EDWARD SOUCEK: Comparison between series of current-meter measurements of discharge over dam and tests of a 1 : 12 scale model of section of dam is presented. Prototype heads covered by measurements ranged from 1.7′ to 6.3′ and discharges ranged from less than 2,000 cfs. to nearly 16,000 cfs. Submergences ranged from less than 12% to nearly 90%. Model discharges avgd. approx. 5% less than comparable discharges obtained from prototype. Comparison would appear somewhat more favorable if made in terms of head. By no means certain that discrepancy chargeable to model. Both model and prototype exhibit considerably smaller diminution of discharge capac., due to submergence, than anticipated. Model tests demonstrate inadequacy of single-valued relations between submergence and reduction in discharge capac. Observations on behavior of nappe presented. Model operated in glass-sided steel flume, 26′ long, 2.5′ deep and 2.56′ wide, glass to glass. Length of prototype spillway 273.5′. Model discharges per ft. of length, therefore, must be multiplied by 22.8 as length adjustment before being "scaled up" by Froude's law. Conclusions are: (1) Effect of submergence on discharge affected by shape of spillway and perhaps by other factors. Use of "typical" data cannot be recommended. (2) In general, not possible to express effect of submergence upon discharge by a single-valued relation between submergence and discharge ratio. In range covered, effect of submergence greater for high discharges. (3) If tailwater elevation measured at sufficient distance from dam, not necessary to consider behavior of nappe in detg. effect of submergence on discharge. For this and other reasons, tailwater el. should be measured beyond immediate effects of dam. *Development of Mississippi River Channel.* FREDERICK R. BROWN: Model study involved development of effective plan for improving navigation channel of Mississippi R. Scale ratios, model to prototype, were: horizontal dimensions 1 : 600 and vertical, 1 : 150. Model of movable bed type, with banks and overbank topography molded in concrete and movable channel section in crushed coal. In general, prototype accurately produced results indicated by model study. *Hydraulic Conditions at Approach to a Lock and Dam.* WILLIAM J. HOPKINS. Dam about 550′ long from left abutment to lock and of concrete gravity type. Modified, uncontrolled ogee spillway section with crest at el. 737.5 provided. To accomodate heavy river traffic in vicinity, two locks having lift of 10.6′ provided along right bank of stream. Approx. 2.4 mi. of river reproduced in model, major part of reach being upstream from structure to develop accurately flow characteristics at upper approach. Model undistorted, on scale of 1 : 200. Details of structure, both in model and prototype, same, so that exact comparison could be made for verification, except for effects of surface tension and channel roughness. Field data necessarily confined to measurements of current directions and surface velocities. Satisfactory verification of model tests for entrance conditions to upper approach of new lock and dam resulted. Model anal. in this case provided direct approach to problem that could not be solved by purely anal. methods.—*H. E. Babbitt.*

Entrainment of Air in Flowing Water. *A Symposium.* Proc. A.S.C.E. **68:** 1099 (Sept. '42). *Open Channel Flow at High Velocities.* L. STANDISH HALL: Problem in design of chutes or steep spillway channels proper free-board allowance for entrainment of air at high velocs. Calcns. of channel dimensions also must be modified with respect to application of normal resistance, which is altered as result of air entrainment. In all cases where water flowing in steep chute is allowed to accelerate over sufficient distance, air is mixed with stream and "white water" results. Incidental to measurement of bulking of water, possible to observe performance of stream while it flowed around vertical and horizontal curves. Flow of water on steep gradients essentially different from that found in channels of ordinary slope. Velocs. greater than critical and range from 10 to 15 fps. to max. of from 80 to 100 fps. Kinetic energy greatly exceeds static pressure of water prism. Flow of water down steep channel with entrained air does not follow continuity eq. $Q = AV$. Retardation factors, n in Manning or Kutter formula, obtained by using observed velocities and areas, agree with those obtained in normal channel flow in similar materials. For practical purposes computations are simplified in design of chutes by use of computed area, assuming no air entrainment. This necessitates use of value of n smaller than that normally used, and one that depends for its value on velocity of water, as indicated by eq.:

$$n_c = n \left[\frac{1 + \frac{BKV^2}{qg}}{1 + \frac{KV^2}{g}\left(\frac{V+B}{q}\right)} \right]^{2/3}$$

Convex vertical curves must not be made sharper than trajectory of flowing water falling under action of gravity as determined from eq:

$$m = \frac{2V^2 \cos^2 \theta}{g}$$

if stream is expected to adhere to bottom of channel. Evidence indicates that more energy dissipated when stream cross-section expanded by leaving floor of chute than would otherwise be case. Under extreme conditions damage to concrete floor of chutes may result from cavitation. On sharp curves, if computed super-elevation of water surface exceeds value of $\tan \psi = 0.120$, super-elevation of bottom recommended. Nomenclature:

n = Kutter's or Manning's roughness coef.
n_c = computed roughness coef. to be used with R_c and V_0
B = substitution const. = $\frac{2q}{b}$
b = width; b_c = water surface of trapezoidal section; b_1 = bottom of trapezoidal section
K = coef. of air entrainment; K_1 = const. for air entrainment
g = acceleration due to gravity
q = unit discharge; flow per foot of width.
V = velocity, avg. in a section
m = parameter of parabola for trajectory of jet
ψ = transverse slope of water surface between inner and outer walls of channel
θ = angle of channel bottom or pipe with horizontal, in deg.

Closed Conduit Flow. A. A. KALINSKE AND JAMES M. ROBERTSON: General problem treated is air entrainment by flowing water in pipes, particularly re removal of air pockets from water supply lines. Formation of hydraulic jump important method by which air can be removed. When air pocket formed at summit of pipeline or beyond partly open gate valve, conduit flows only partly full and at end of pocket hydraulic jump usually occurs. Violent eddies of hydraulic jump at end of pocket will entrain and pump air into conduit beyond jump. If slope of conduit not greater than hydraulic gradient, bubbles moved along without difficulty. Jump in closed conduit can be anald. by use of momentum principle in same manner as in open conduits. General relationship is:

$$F_1 + M_1 = F_2 + M_2 - W \sin \theta$$

in which F_1 and F_2 are total pressures in lb. at sec. (1) and (2), resp., M_1 and M_2 are total momentums of water at sec. (1) and (2) resp., W is weight or jump, and θ is angle conduit makes with horizontal. Frictional effects at conduit walls neglected. Weight of jump computed from observations of length of jump, area of pipe, A_p, and unit weight of water corrected for entrained air. Above certain critical condition, rate of air removal from air pocket will depend on ability of hydraulic jump to entrain air. This condition depends on value of Froude no. of flow ahead of jump. Below this critical value of Froude no., flow beyond jump will not be able to handle all air entrained by jump and thus air removal will not be function of jump characteristics but rather of hydraulic features of flow beyond jump. Air-flow measurements indicated that rate of air entrainment by jump depended largely on water discharge and Froude no. of flow ahead of jump. Empirical relationship presented for air flow as

$$\beta = 0.0066\,(\mathbf{F}_1 - 1)^{1.4}$$

in which β = air-water flow ratio and $\mathbf{F}$ = Froude's no., subscripts referring to given sections.—*H. E. Babbitt.*

New Information About Flow of Fluids in the Critical Region. ANON. Heatg., Piping & Air-Condg. **14:** 541 (Sept. '42). Three classifications of flow in eng. computations, *viz.* streamline, critical and turbulent. Reynolds discovered type of flow depends only upon dimensionless modulus, referred to as Reynolds number. **R** below 1,000, flow streamline; above 5,000, turbulent; between 1,000 and 5,000, critical. Always uncertain as to exact location of critical region. A. H. Nissan reported exptl. results indicating critical region shows 3 distinct phases: (1) 1,000 to 2,200, termed *pre-critical;* (2) 2,200 to 2,500, approx., *true critical;* (3) 2,500 to 5,000, *post-critical.* In pre-critical region, head-loss with increasing veloc. increases at slightly greater rate than in **R** less than 1,000. In true critical region, change in head very great with almost negligible increase in flow. In post-critical region, head increases linearly with veloc.

Rate of increase much greater than in pre-critical but much less than in critical region where rate almost infinite because of vertical line of head *vs.* veloc. Flow in range 1,000 to 5,000 exhibited many erratic and hitherto unexplainable phenomena.—*Ralph E. Noble.*

Velocity Formula—Rivers and Pipes. C. R. Pettis. Ohio State Univ. Eng. Expt. Sta. News **14:** 5 : 4 ('42). In practically all flow formulas, effort made to express mean velocity as a function of roughness (C), slope (S) and hydr. radius (R). Usually, relation involves single use of each term. In data obtained from large no. of carefully selected tests made by U.S. Lake Survey and checked from voluminous data submitted originally by Kutter, deduced that use of different form of equation necessary. Great care in selecting cross-sections of "balanced" velocities and use of established channels of 40 yr. standing assured most reliable results. Taking Taylor's theory that vertical veloc. curve is a cycloidal, avg. veloc. (at 0.6 depth) is $V_6 = V_0 - 0.28U_x$, where $V_0 = 100S^{0.5}R^{0.5}$ and $U_x = 100S^{0.5}R^{0.25}$, combining into:

$$V_c = V_6 = 100S^{0.5}R^{0.5} - 28S^{0.5}R^{0.25}$$

or:

$$V_6 = 100S^{0.5}R^{0.5}(1 - 0.28R^{-0.25})$$

Investigations by author indicate that theory of Taylor is correct and that neither a log nor parabolic curve will agree with phys. data for a balanced vertical veloc. curve. Mean veloc. approx. and theoretically obtained at the 0.6 depth, but more correctly should be 0.62 depth. Difference caused by depressions in bottom or stream bed. Comparisons made by selecting 400 of Kutter's original 1200 compiled readings. These data indicated proposed formula to be in very close agreement with various records. Also, proposed formula found to be a medium of several well-known pipe-flow and open-channel formulas. Formula based primarily on data from Lake Survey for depths 19′ to 55′ and based on uniform stabilized turbulent flow as indicated by Reynolds no. [H. W. Mills deduced many years ago that fundamental relation between V, R and S could not be simply expressed with single term for each, but used different powers of V rather than for R. Ultimate result quite similar.]—*Charles H. Capen.*

Pressure Drop Calculations for Flow in Pipes. James A. Hardy & Emory N. Kemler. Heatg. & Ventg. **39:** 8: 43 (Aug. '42). Authors developed new variation in method of handling velocity nos. re design of piping. Introduced, also, entirely new and simplified method of calcg. pressure drop in flow of liq., gas and vapors, knowing viscosity and density of given fluid and using friction factor curves. Likewise, latter used for any type of conduit provided relative roughness known. Ordinarily encountered types of rough conduits listed. Velocity no., reported here, affords simple calcn. to det. rate of flow. Method for making compressible flow calcns. quite simplified over conventional ones.—*Ralph E. Noble.*

Friction Heads Due to Water Flow in Copper, Brass and Other Smooth Pipes. F. E. Giesecke. Heatg., Piping & Air-Condg. **14:** 680 (Nov. '42). Author compares exptl. detn. of friction heads in brass pipes, made in 1892 by John R. Freeman and published in '41 by ASME, with other exptl. detns., and development of formula for friction heads of 140°F. water flowing in Type M copper tubes.—*Ralph E. Noble.*

Flow Characteristics at Rectangular Open-Channel Junctions. Edward H. Taylor. Proc. A.S.C.E. **68:** 1521 (Nov. '42). When two streams combine in a single channel, depth just below junction will be fixed by backwater characteristics of that channel and magnitudes of combined rates of flow. Problem is to predict depth in each tributary channel just upstream from junction. Generalization of results presented not possible so that no attempt made to present math. statement applicable to every type of stream intersection. Tests conducted in small, horizontal, rectangular channels, all 4″ wide, and with max. depth of 4″. Intersections constructed of transparent plastic and remainder of channels built of galvanized sheet metal. Channels are of equal width, bottom slopes are all zero, flow is from channels 1 and 2 into channel 3, channels 1 and 3 lie in straight line (angle between channels 1 and 2 is θ), flow is parallel to channel walls immediately above and below junction, ordinary wall friction is negligible in comparison with other forces involved, and depths in channels 1 and 2 are equal immediately above junction. Agreement between theory and expt. for 45° junction supports conclusion that all aforementioned assumptions are justified in this case of combining flow. Since boundary friction was same in both cases, it may be considered as negligible influence in comparison with

other forces. Exptl. data clearly showed that depths in two channels upstream from junction had nearly same value, regardless of angle of intersection. Lack of agreement between theory and expt. for 135° intersection due to distortion of velocity distr. below junction and to fact that flow does not remain parallel to channel walls. Results show clearly that, owing to negligible effect of friction, model studies of special stream intersections would be successful.—*H. E. Babbitt.*

Testing Theoretical Losses in Open-Channel Flow. *Part I. Superelevation at Bends.* J. G. Jobes & J. H. Douma. Civ. Eng. **12:** 613 (Nov. '42). Superelevation in open channels is quite different for tranquil and for rapid flow. These states of flow frequently referred to as alternate stages of flow, greater depth (above critical) being tranquil and smaller depth (below critical) being rapid. Tranquil flow around bend results in rise e_s in water surface along outside wall:

$$e_s = \frac{V^2 b}{2gr_c} \qquad (1)$$

where V = mean velocity of flow, b = channel width, g = gravitational const., and r_c = center-line radius. In rapid flow, max. superelevation is considerably greater, and it is not uniform around bend, but has max. and min. zones which persist for considerable distance into downstream tangent. For rapid flow, magnitude of max. superelevation along outside wall is:

$$e_s = \frac{V^2 b}{gr_c} \qquad (3)$$

From results of expts. following formula for superelevation in trapezoidal channels derived:

$$e_s = \frac{CV^2(b + 2sy)}{2(gr_c - 2sV^2)} \qquad (5)$$

where s is channel side slope, C is constant whose value is recommended as 1.0 for tranquil and 2.0 for rapid flow, and y is mean depth. Depression on opposite side of channel is:

$$e_d = \frac{CV^2(b + 2sy)}{2(gr_c + 2sV^2)} \qquad (6)$$

Total max. difference in water-surface levels at inner and outer walls is sum of Eqs. 5 and 6. For case of rapid flow in rectangular channel some of exptl. results fairly consistent with curve computed from eq:

$$e_s = \frac{1.2\,V^2 b}{gr_c} \qquad (4)$$

Field observations of superelevation in rectangular channels were made. In general, formulas presented appear to be satisfactory design criteria for computation of max. superelevation in open channel flow.—*H. E. Babbitt.*

Profile Curves for Open-Channel Flow. Dwight F. Gunder. Proc. A.S.C.E. **68:** 535, 1247 (Apr., Sept. '42). In calcg. surface profile curves for gradually varied flow in open channels, using customary step-by-step method in combination with differential eq. of gradually varied flow, writer found certain irregularities in results. These consisted of deviations from general shape for such curves as found in std. texts treating subject of gradually varied flow. Deviations occurred in case where flow was at depths less than either critical, y_c, or normal, y_o. For normal conditions of flow:

$$\frac{dy}{dx} = \frac{S_o\left(1 - \dfrac{C_o^2 y_o^3}{C^2 y^3}\right)}{1 - \dfrac{y_c^3}{y^3}}$$

in which x is distance measured in direction of flow; C is Chezy coef., C_o is value of C when flow is at normal depth. For Manning relation $C = 1.486\,\dfrac{R^{1/6}}{n}$, in which R is hydr. radius, and n is Manning's roughness factor. This value of C, when substituted in above eq. gives:

$$\frac{dy}{dx} = S_o\left[\frac{1 - \left(\dfrac{y_o}{y}\right)^{10/3}}{1 - \left(\dfrac{y_c}{y}\right)^{3}}\right]$$

which, when integrated, results in:

$$x = \frac{y}{S_o} + 0.306\,\frac{y_c^3}{S_o y_o^2} + \frac{0.3}{S_o y_o}K$$

in which K is a substitution factor. Foregoing solution enables one to draw quantitative graphs of various profile curves for channel type considered here. *Discussion.* C. J. Posey: One wavers between two conclusions —that author is wrong or that backwater curves shown in std. texts seriously in error. Fortunately, neither conclusion correct. In

drawing small-scale illustrations, true shape of curves often must be modified. For example author's curves start up from bottom at right angles to it, whereas according to text of paper they should start up vertically. This peculiar feature of curves can easily be shown to be consistent with assumptions ordinarily made in computing backwater curves. From practical viewpoint there seems little choice between results obtained using variable Chezy coef. and those obtained using const. coef. *Discussion. Ibid.* **68:** 1413, 1646 (Oct., Nov. '42). J. C. STEVENS: Suggested that author be sentenced to prepare table of values of his K-factor, in terms of y, y_c, and y_o, varying by tenths of feet to 50′. One wonders how large a vol. it would make. Appears as though hydr. engrs. will have to struggle along with their old step-by-step method of computing water surface profiles. BORIS A. BAKHMETEFF & NICHOLOS V. FEDOROFF: Serious error that has remained unnoticed in hydr. literature for years has been disclosed by author. Only proper to accept author's discoveries as regular characteristics of M_3 varied flow curves, especially as these properties seem to have broader signif. than that suggested by paper, and as they will be found to obtain quite generally, irrespective of particular formula used for the C-factor. Following anal. complements author's pioneer findings, which from now on should replace all former ideas relating to M_3 curves. All surface curves, both of M_3 and S_3 class, tend to be theoretically vertical at $y = 0$. In the reach of small depths M_3 curve must be convex and, therefore, at some depth y_i, there is inflection of curvature, with surface profile changing from convex to concave. Unfortunately very little known about resistances in rapid (shooting) motion. Here that writers cannot follow author's conclusions, for their investigations seem to show that choice of any relation for C does not materially affect position of inflection point. Location of "inflection depth" y_i on M_3 curve can be expressed conveniently in dimensionless terms by ratio:

$$\frac{y_i}{y_c} = \frac{\text{inflection depth}}{\text{critical depth}} = (y_c')_i$$

Under ordinary circumstances, for $y \gtrsim 0.6y_o$, the simpler expression:

$$(y_c')_{iS_o=0} = \sqrt[3]{\frac{m-3}{3}}$$

can be used for quick appraisals. In view of "flatness" of M_3 curves, desirable to know more about their eventual outline in regions adjoining inflection point. General procedure would be cumbersome and ineffective, so recourse must be had to practical examples. All dy/dx curves exhibit only slight change over comparatively wide middle reach, revealing previously emphasized flatness of M_3 curve. M_3 surface curves occur at foot of spillways and chutes, where steep incline changes to mild slope channel, or at point where water flows from beneath sluice into horizontal or mildly sloped bed. In either case, initial surface, in transition reach, is concave. Accordingly, if initial depth is less than y_i, subsequent flow must exhibit portion of convex surface between two concave reaches. One could reasonably expect that lower theoretical convex part of profile will prove in reality to be more or less undulated. Special expts. confirm such anticipation. Question arises: Why were not all these facts noticed and recorded in former research? Answer may possibly be found in general flatness of M_3 curves and especially in fact that profile measurements were taken mostly at considerable intervals. HUNTER ROUSE: Writer believes that conclusions in this paper would be far more signif. if freed from handicap of being based upon resistance formulas in themselves none too trustworthy. Shown both experimentally and analytically that actual resistance due to wall roughness varies with log, rather than some power, of relative roughness. Since log and power functions can approx. coincide over only limited range, author's curves necessarily reflect discrepancies to ever-increasing deg. as they approach upper or lower limit.—*H. E. Babbitt.*

The Hydraulic Jump in Sloping Channels. CARL E. KINDSVATER. Proc. A.S.C.E. **68:** 1473 (Nov. '42). Sufficient verification data now exist to substantiate application of momentum principle to hydr. jump in open or enclosed conduits of any practical cross-sectional shape. To apply principle to anal. of hydr. jump in sloping channels, however, necessary to obtain floor pressures and certain elements of jump profile from lab. expt. Hydr. jump occurs under many conditions in no. of related forms. Four basic cases selected for present anal. are: (1) With entire roller on horizontal floor, jump is in horizontal channels. (2) Toe of roller is on slope and end of roller on horizontal floor. (3) Toe of roller is on slope and end at junction of

sloping and horizontal floors. (4) Entire roller is on slope. In each case water surface and channel bottom downstream from jump, as well as reference axis, assumed to be horizontal in Case 1:

$$d_2 = \frac{d_1}{2}(\sqrt{8\lambda + 1} - 1) \ldots\ldots (3)$$

No. of practical limitations to application of generalized anal. of hydr. jump in sloping channels. On very steep slopes on large structures, problem often complicated by entrainment of air before jump or by formation of traveling waves on surface of stream. Careful observation of several hundred jumps on slopes from 1 : 6 to 1 : 1 indicate that sloping-floor jump generally similar to jump in horizontal channels. Length of jump prerequisite to anal. of jump in sloping channels. If channel slope continuous, as in Case 4, some expansion may occur beyond end of jump. Thus, for anal. purposes, necessary to know min. length of expansion for which depth of tailwater at section 2 sufficient to insure formation of jump. Possible to approx. length of jump with assumed const., "safe length," but tailwater depths detd. in this manner usually exceed depth required to produce jump. For practical use, desirable to have equation for depth of tailwater, d_2:

$$d_2 = \frac{d_1}{2\cos\alpha}\left(\sqrt{\frac{8\lambda\cos^3\alpha}{1-2\phi\tan\alpha}+1}-1\right) \ldots (14)$$

λ is dimensionless criterion for dynamic similarity which is square of Froude's no:

$$\phi = \frac{gL_r}{d_2^2 - \dfrac{d_1^2}{\cos^2\alpha}} \ldots\ldots (18)$$

In nearly every practical case, location of section 1 at toe of jump must be assumed in first approx. for d_2 in order that d_1, λ, and ϕ, can be evaluated from known conditions. If jump falls in Case 2, length L_s must also be assumed. Results obtained from initial assumptions can readily be refined by successive approximations. Nomenclature:

d = depth of flow
d_1 = depth at section 1, toe of jump
d_2 = depth at section 2, end of jump
g = acceleration due to gravity
L = length along channel
L_r = length of roller
L_s = length along sloping channel floor
V = avg. veloc. of flow
V_1 = avg. veloc. at section 1
α = slope angle
Tan = slope of channel
λ = kinetic flow factor, $\frac{V_1^2}{gd_1}$.—*H. E. Babbitt.*

Water Volume in Partly Filled Tunnel. LOUIS J. SACK. Eng. News-Rec. **128:** 33 (July 2, '42). Formula developed for rapid, accurate calcn. of vol. of water in partially filled, graded tunnel described, together with example of application to given problem.—*R. E. Thompson.*

Viscosity and Surface Tension Effects on V-Notch Weir Coefficients. ARNO T. LENZ. Proc. A.S.C.E. **68:** 351 (Mar. '42) (*Abstracted Jour. A.W.W.A.* **34:** 1473 ('42). *Discussion. Ibid.* **68:** 1033, 1199 (Mar., Sept. '42). A. A. KALINSKE: Writer cannot agree that general eq. has been derived relating all pertinent variables. Fact that eq. dimensionally consistent does not necessarily mean it is generally applicable. Although entirely empirical eqs. with clearly defined limitations are useful, curve or curves indicating values of C for all practical ranges of **R** and **W** probably would be best so far as eng. use concerned. GLEN N. COX AND F. J. GERMANO: Would increase value of paper if author would prepare 3-dimensional fig. showing plane on which line $C - C_x = \frac{B_x}{\mathbf{R}^n\mathbf{W}^m}$ appears and showing projections of this line that give eqs. $C - C_1 = \frac{B_1}{\mathbf{R}^n}$ and $C - C_2 = \frac{B_2}{\mathbf{W}^m}$. Values of m and n should be indicated, as well as 3 values of B for these eqs. Would appear that undue emphasis placed on failure of $C - C_x = \frac{B_x}{\mathbf{R}^n\mathbf{W}^m}$ to apply for full range in values of **R** and **W**. EMERY H. WILLES: Is it true that weir coef. will increase with viscosity and surface tension? Statement is just opposite from that which writer would expect, for viscosity is reciprocal and not measure of fluidity. What then is answer to apparent reversal of natural laws? "π-theorem" method of dimensional anal., because value has been proved in model expts. in hydraulic labs., now often used. Because of increase in importance, detailed investigation of development of theorem may

be in order. Substituting values of π in eq.

$$f(\pi_1, \pi_2 \cdots \pi_{n-k}) = 0$$

and solving for C, as demonstrated by author, will yield $C = f''\left(\frac{1}{\mathbf{R}} \cdot \frac{1}{\mathbf{W}}\right)$. Writer takes exception to author's statement: "Fundamental relationship, f'', between C, $\mathbf{R}$, and $\mathbf{W}$ for given weir must be obtained from exptl. data." There is theoretical solution to every problem in nature. Eq. will be of form:

$$N_1(\pi^{n_1})_1(\pi^{m_2})_2 + N_2(\pi^{n_2})_1(\pi^{m_2})_2 + \cdots N_n(\pi^{n_n})_1(\pi^{m_n})_2 = 0$$

[From this it is shown that:]

$$C - C_z = \frac{B_z}{\mathbf{R}_n \mathbf{W}^m}$$

Ralph W. Powell: Paper long desired as it not only lays basis for measurement of viscous liquids by means of notch weirs but also indicates way in which flow of less vicsous fluids, like water, may be affected by changes of temp. When one consults handbook for possible liquids that would give wider range of kinematic surface tensions than those used by author, search not very rewarding. Water best liquid with which to study low Weber nos. and Barr's expts. ran down to Weber's no. of about 54. For water at temp. assumed, **R** and **W** computed for no. of different heads, and from these C computed:

$$C = 0.565 + \frac{0.435}{\mathbf{R}^{1/3}} + \frac{0.102}{\mathbf{W}^{1/4}}$$

Physical chemists have discovered that certain solutions, such as 500 ppm. of peptone in water, or 100 ppm. of saponin in water, have what is called "surface viscosity." This quite different from ordinary bulk viscosity and seems to be due to formation of plastic surface film. Not likely that liquids used by author had this property, but would seem probable that, if liquid had it, flow over notched weir would be affected thereby.—*H. E. Babbitt.*

Charts Solve Multiple-Reservoir Problem. Joseph A. Novoro. Eng. News-Rec. **129:** 300 (Aug. 27, '42). Anal. of flows from multiple reservoirs can be performed graphically with ease by set of Williams-Hazen tables or charts giving friction losses. To det. graphically all individual discharges for given total flow involves somewhat more work than with Muir's soln. (Jour. A.W.W.A. **34:** 1476 ('42)) using Hardy Cross method, but once required charts have been prepd. possible to study effects of several different total discharges with very little effort. Prepn. of charts and application to specific problem described.—*R. E. Thompson.*

The Turbulent Spread of a Water Jet. A. M. Binnie. Engineering (Br.) **153:** 503 (June 26, '42). Turbulent spreading of jet projected into large vol. of fluid at rest studied theoretically by boundary-layer methods. Tollmein adopted moment-transfer theory. For jet symmetrical about axis and having uniform veloc., in absence of gravitational forces, mixing zone conical, and at its edge $\frac{\eta}{c^{2/3}} = 3.4$; where x is measured along axis, r at right angles to it, $\eta = \frac{r}{x}$, c is a const., and mixing length l equals cx. Expts. on this subject have been carried out in open-jet wind tunnels and attention concd. on veloc. distr. in mixing zone, which has been found to agree with Tollmein's theory. In expts. described, water jet used in which veloc. over whole of cross-section almost certainly more uniform than in best wind tunnels, thus conforming more closely to assumptions made in theory. From photographs, verified that mixing zone conical over considerable distance. Complicated motion near jet entry examd. by Kuethe, who assumed existence of core of potential flow inside first part of mixing zone. To make core of potential flow visible, necessary to add reacting chems. to water so that whole of mixing zone would disappear, but colored core remain visible.—*H. E. Babbitt.*

Occupational Deferment of Water Works Employees

Selective Service Occupational Bulletin No. 9

DEFERMENT of water works employees is provided for in Selective Service Bulletin No. 9, presented herewith. It should be studied carefully by every manager or superintendent, as well as by all men subject to induction under the terms of the Selective Service Act.

No one should forget that all deferments are subject to review and must be considered temporary. It is also important to remember that local draft boards cannot be expected to keep in mind the jobs listed in all occupational bulletins. They are busy, hard-working men and need your cooperation. Draft boards are guided by this bulletin, but are not bound to exempt every person who holds a job in the list of titles.

Employers may seek the deferment of their necessary men with or without their consent. Here is how they go about it. On page 3 of the Selective Service Questionnaire (Form 40), which is sent to each registrant before he is classified, is the following:

"*Instructions:* If your employer believes that you are a necessary man in a necessary occupation, it is his duty to fill out form 42A requesting your deferment. You may also attach to this page any further statement by yourself which you think the local board should consider in determining your classification. Such statement will then become a part of the questionnaire." *

For each such necessary employee who is already deferred by reason of dependency (Class III-A), you should file a Form 42B with his local draft board. Later if the board proposes to reclassify this man, you will be notified. You should then file with the board the longer affidavit (Form 42 (General) or Form 42A). If the employee is not eligible for deferment on the basis of dependency, Form 42B does not apply, so the affidavit form should be filed immediately.

All three forms referred to above are reproduced herewith (pages 377–80). As will be noted from the illustration, Form 42B is merely an "Occupational Certification," applying for Class III-B deferment for a man who is already in

This information was mailed to all members of the Association under date of February 2, 1943.

* Subsequent to the issuance of these instructions, Forms 42 (General) and 42B were issued as an alternative and a supplement, respectively, to Form 42A. Their use is outlined below.

Class III-A, i.e., deferment on the grounds of both dependency and occupation. When such a registrant is to be considered for reclassification into a class available for military service, the employer is notified on the notice attached to the form, giving him an opportunity to file the "Affidavit—Occupational Classification" (Form 42 or 42A), which is an application for Class II deferment, i.e., deferment on the grounds of occupation only. Thus, the affidavit form must be filed immediately for such employees as are not eligible for Class III-B deferment.

Form 42A should be filed for employees who are necessary by reason of their technical or mechanical knowledge or skill. Engineers, operators, chemists, shop workers, etc., come under this classification.

Form 42 should be filed for employees who are necessary by reason of their administrative or other non-technical knowledge or skill. Superintendents and managers, whose activities are almost entirely executive, accountants, etc., come under this classification.

In general, the distinction is that Form 42A applies to the deferment of practicing technical and scientific men and Form 42 to those whose activities are confined to desk work.†

† This information on the application and use of the three forms was obtained in a personal interview at New York City Selective Service System Headquarters.

If deferment should be denied because the man, after consideration of the claims offered for him, is not considered to be indispensable to the company's operation and is needed more in the armed services, the local board will advise the employer of its refusal of such an occupational deferment. The local board does this by sending to the employer, at the same time it notifies the registrant of his classification, a Form 59. For ten days after Form 59 is mailed by the local board to the employer, the employer can appeal the registrant's case. The registrant will not be ordered to report for induction during this ten-day period.

To make an appeal, the employer must simply sign his name to the Form 59 which he has received and return it to the local board; or, if the Form 59 is not received from the local board, any written request will have full value to make such an appeal effective. When Form 59 is returned by the employer, the appeal procedure becomes automatic.

If the local board and the appeal board deny the appeal for the occupational deferment of a key man, the employer may then bring the matter to the attention of the State Director at the State Selective Service Headquarters, with the request that the case be reopened or appealed by him to the President.—HARRY E. JORDAN, *Secretary.*

NATIONAL HEADQUARTERS

SELECTIVE SERVICE SYSTEM

WASHINGTON, D.C.

January 20, 1943

OCCUPATIONAL BULLETIN No. 9 (*Amended January 19, 1943*)

EFFECTIVE: *Immediately*

SUBJECT: *Heating, Power, Water Supply and Illuminating Services*

1. The War Manpower Commission has certified that heating, power, water supply and illuminating services are activities essential to the support of the war effort.

2. This bulletin covers the following essential activities which are considered as included within the list attached to Local Board Release No. 115, as amended:

(a) *Heating, power, water supply and illuminating services:* Electric light and power, water supply and gas utilities; steam-heating companies.

3. The following list of occupations in heating, power, water supply, and illuminating services are occupations requiring a reasonable degree of training, qualification or skill to perform the duties involved. It is the purpose of this list to set forth the important occupations in heating, power, water supply and illuminating services which must be filled by persons capable of performing the duties involved in order that the activities may be efficiently maintained. This list is confined to those occupations which require six months or more of training and preparation.

4. In classifying registrants employed in these activities, consideration should be given to the following:

(a) The training, qualification, or skill required for the proper discharge of the duties involved in his occupation;

(b) The training, qualification, or skill of the registrant to engage in his occupation; and

(c) The availability of persons with his qualifications or skill, or who can be trained to his qualification, to replace the registrant, and the time in which such replacement can be made.

(signed)
LEWIS B. HERSHEY
Director

LBH/phw
Distribution "A,B,C,D,E,F"

OCCUPATIONAL BULLETIN NO. 9, AMENDED JANUARY 19, 1943

Critical Occupations

Heating, Power, Water Supply and Illuminating Services

Accountant, Audit (Included under this title are those persons who design and install accounting systems for the activity listed above; who assume extensive responsibility for the examination and verification of accounting records and prepare comprehensive financial reports based thereon. It does not include persons who perform routine auditing duties under general supervision, such as verifying, checking, etc.)

Armature Winder (This title covers those persons who install, repair and wind coils to motors, generators and transformers in electric power systems.)

Auxiliary Equipment Operator (All Around) (This title includes only those persons who actually control and adjust boiler and turbine auxiliary equipment such as condensers, fans, pumps and pulverizers. It does not include such occupations as oilers and wipers.)

Bacteriologist

Batteryman, Large Emergency Storage

Blacksmith, Maintenance

Boiler Operator

Boilermaker, Maintenance

Booster-Pump Operator

Bricklayer, Maintenance Refractory

By-Products Operator, Gas

Cable Splicer (This title covers persons who install, repair and maintain overhead or underground power cables.)

Carpenter, Maintenance

Chemist

Chief Operator, Water Purification or Softening

Crane Operator

District Serviceman (Electric Power)

Draftsman, Engineering

Driller, Water Well

Electrical Tester

Electrician, System or Plant

Engineer, Professional and Technical (This title covers persons who are actually engaged as engineers in the operating and research phases of the activity described above, regardless of educational background.)

Engineer, Turbine or Diesel

Foreman (This title covers Foremen who are actually engaged in supervisory duties in connection with the activities described above and who exercise independent judgment and assume extensive responsibility for the services. It does not include laboring gang Foremen.)

Gas Equipment and Control Man

Gas Maker

Heavy Mobile Equipment Operator (Maintenance and Construction) (This title covers persons who operate and make minor repairs to one or more of the following types of equipment: ditching machines, hole diggers, pole raising devices, winches, etc., for the activities specified above. It does not cover truck drivers or tractor drivers.)

Inspector (This title covers persons who are responsible for inspection du-

ties involving standards of operating efficiency, safety, specifications on construction, etc., to insure the continued uninterrupted services specified in this list.)

Instructor, Training Program (This title covers only those persons engaged in the occupations included in this list who, because of their skill and experience, are detailed as instructors in an established training program.)

Lead Burner

Lineman

Load Dispatcher, Power or Gas

Machinist, Maintenance

Manager, Employment and Personnel

Mechanic, Maintenance

Meter Repairman, Gas and Water

Patrolman, Transmission Line

Pipe Fitter, Maintenance

Purification Operator, Gas

Pusher Man

Radio Technician

Rigger, Construction

Rigger Supervisory, Underground Cable

Sheet-Metal Worker, Maintenance

Storekeeper, Chief (This title includes those persons responsible for the operation of a store, department, or major subdivision. It does not include such persons as stock clerks, bin clerks, or stockhandlers.)

Substation Operator

Superintendent or Manager (Division, District, Plant and Department) (This title covers those persons who are actively engaged in supervising directly, or through subordinates, various technical or operating departments in the heating, power, water supply and illuminating services. This title covers those assistants who are directly responsible to such managers on a division or district level for the efficient functioning of the technical or operating departments . It does not cover managers or their assistants who are concerned primarily with sales, promotional, legal, tax, clerical, insurance, rate structure and other aspects of nontechnical or nonoperating activity.)

Switchboard Operator, Power

System Operator (Load Dispatcher)

Tree Trimming Supervisor (Overhead Power Lines)

Welder (All Around)

DSS Form 42B
(Revised 11-16-42)

SELECTIVE SERVICE SYSTEM

Budget Bureau No. 33-R016-42
Approval expires March 31, 1943

OCCUPATIONAL CERTIFICATION

Name of employer ____________________

Address of employer ____________________

Brief description of activities of employer ____________________

____

Name of registrant ____________________ Order No. ________

Local board ____________________
(Number) (County) (City) (State)

Title of present job ____________________

Brief description of duties ____________________

____

Is registrant employed full time? ________ Part time? ________

(If the registrant is self-employed, he may sign this certification himself)

I, ____________________, DO HEREBY CERTIFY that the foregoing statements are true to the best of my knowledge and belief.

____
(Name of employer)

____
(Signature of person certifying)

____________________, 19____
(Date of mailing)

____
(Title)

GPO 16—31535-1

Instructions.—This form is to be filled out (including name of registrant and local board designation on return notice) by an employer or other person who has knowledge of the registrant's eligibility for Class III–B deferment under the provisions of section 622.31–1, Selective Service Regulations. If the registrant is self-employed, he may complete and file this form himself.

The local board will give consideration to the classification into Class III–B of the registrant for whom Form 42B is filed.

If the local board upon review determines that the registrant should be considered for classification into a class available for military service, it will notify the employer by mailing him the attached notice, and will give him an opportunity to file Affidavit—Occupational Classification (Form 42 or Form 42A) for such registrant before completing the classification.

Budget Bureau No. 33-R016-42
Approval expires March 31, 1943

NOTICE TO EMPLOYER OF REOPENING CLASSIFICATION

____________________, 19____
(Date of mailing by local board)

Name of registrant ____________________ Order No. ________

Local board ____________________
(Number) (County) (City) (State)

The classification of the above-named registrant has been reviewed, and will be reopened and considered anew 15 days after the above date. If you wish to file Affidavit—Occupational Classification (Form 42 or Form 42A) because of the occupational necessity of this registrant, such evidence must be forwarded to the local board within this 15-day period.

____
(Member—Clerk of Local Board)

DSS Form 42B
(Revised 11-16-42)

U. S. GOVERNMENT PRINTING OFFICE 16—31535-1

SELECTIVE SERVICE SYSTEM

Budget Bureau No. 33-R003-0
Approval Expires March 31, 1943

AFFIDAVIT—OCCUPATIONAL CLASSIFICATION (Industrial)

(Affidavit—Occupational Classification (General), Form 42, is provided for use in activities where the items on this form are not applicable)

Name of registrant ....

Selective Service Order No. .... Age ....

Local Board ....
(Number) (County) (City) (State)

COPY

Title of present job ....

....

State whether journeyman, apprentice, helper, certificated, licensed, professional engineer, etc.:

....

Describe duties actually performed ....

....
(Be specific—include name of machine or machine tool, process, materials, etc.)

....

COPY

....

....

Date employed .... Date entered present job ....

Average weekly rate of pay, $.................... Average hours worked per week ....

Prior work experience ....

....

....

COPY

Educational background ....
(Fill out if necessary to establish employee's qualifications for a particular job)

....

....

How long will it take you to replace this employee? ....

....

....

What specific steps have you taken to secure or train a replacement for this registrant? ....

....

....

....

D. S. S. Form 42A
(Revised 9-15-42)

[OVER]

AFFIDAVIT—OCCUPATIONAL CLASSIFICATION (Industrial)—Continued.

Name of company ....
(Corporation, partnership, individual—if self-employed, so state)

Address of company ....
(Location of plant, office, or division where registrant is employed)

Description of the activities of this company ....

State specifically what proportion of your products currently produced are:
(a) for use in the war effort ....
(b) for civilian use ....

Is expansion or further conversion contemplated in war production? ....

Number employees now .... Number additional needed in next 6 months .... Number additional needed in next year ....

Explain ....

Is a replacement training program in operation? .... Contemplated? ....

Explain ....

This form was completed at the plant or office of the company located at

....

and all correspondence relative to this affidavit should be so addressed.

I, ..., do solemnly swear (or affirm)

that I am .... of the above-named company, and that the
(Official position)

foregoing statements are true to the best of my knowledge and belief.

....
(Signature)

Subscribed and sworn to before me this .... day of ...., 19......

....
(Signature of official administering oath)

....
(Official designation of official administering oath)

INSTRUCTIONS: This form is to be filled out by an employer or other person who has knowledge of the registrant's eligibility for Class II deferment as a necessary man in his civilian occupation or activity. *If the registrant is deferred, the employer must notify the Local Board promptly of any change in the registrant's job status, or if his employment is terminated.*

U. S. GOVERNMENT PRINTING OFFICE : 1942—O—453249

F A C E

SELECTIVE SERVICE SYSTEM

BUDGET BUREAU No. [illegible]
Approval Expires March 31, [illegible]

AFFIDAVIT—OCCUPATIONAL CLASSIFICATION (GENERAL)

(This form is provided for use in activities where Affidavit—Occupational Classification (Industrial), Form 42A, is not applicable)

NAME ....

SELECTIVE SERVICE ORDER No. .... AGE ....

LOCAL BOARD ....
(Number) (County) (City) (State)

COPY

I, ..., do solemnly swear (or affirm) that the foregoing statements are true to the best of my knowledge and belief.

....
(Signature)

....
(Address)

Subscribed and sworn to before me this .... day of ...., 19......

COPY

....
(Signature of official administering oath)

....
(Official designation of official administering oath)

(See other side for instructions)

Form 42 (Revised 9-15-42) [illegible]

R E V E R S E

AFFIDAVIT—OCCUPATIONAL CLASSIFICATION (GENERAL)

(This form is provided for use in activities where Affidavit—Occupational Classification (Industrial), Form 42A, is not applicable)

This form is to be filled out by an employer or any other person who has knowledge of the registrant's eligibility for Class II deferment as a necessary man in his civilian occupation or activity.

Evidence submitted to the local board may be included in or attached to this form and may include any documents, affidavits, or other information.

If the registrant is deferred, the employer must notify the local board promptly of any change in his job status, or if his employment is terminated.

The oath required by this form may be administered by any civil officer authorized to administer oaths generally, any commissioned officer of the land or naval forces assigned for duty with the Selective Service System, any member or clerk of a local board or board of appeal, any Government appeal agent or associate Government appeal agent, any member or associate member of an advisory board for registrants, any postmaster, acting postmaster, or assistant postmaster.

No fee shall be charged by any person for administering the oath required on this form.

U. S. GOVERNMENT PRINTING OFFICE 16—30280-1

Duties of U.S. Citizens Defense Corps in Gas Defense

A PROGRAM for civilian protection against gas is being rapidly developed by the Medical Division of the Office of Civilian Defense. Courses have been presented for physicians selected from the faculties of medical schools to be trained as instructors in the medical aspects of chemical warfare. Arrangements are now being made for the presentation of courses by these instructors in their own medical schools.

Training for non-medical personnel is provided in Gas Specialist Courses which since early December have been presented monthly at War Dept. Civilian Protection Schools. These schools are located at Amherst College, Amherst, Mass.; Purdue University, Lafayette, Ind.; Loyola University, New Orleans; Occidental College, Los Angeles; Stanford University, Palo Alto, Calif.; and the University of Washington, Seattle, Wash.

The Gas Protection Service of the U.S. Citizens Defense Corps has been organized as follows: The Medical Division of the Office of Civilian Defense has a Gas Protection Section responsible for organization and training for gas defense. This section functions through the nine Civilian Defense Regions, which are coterminous with the Service Commands of the U.S. Army. Regional Gas Officers have been designated for several of the coastal Regions to supervise and assist the State Gas Consultants and the Senior Gas Officers of defense councils in the organization of state and local programs. The Senior Gas Officer trains Gas Reconnaissance Agents who serve in each zone of the city. These men are responsible for the identification of the agent, the collection of samples, the prevention of casualties, the delimiting of gassed areas, and for co-operation with the Emergency Medical Service, the health department and other agencies concerned in protection against gas.

Instructions to members of the U.S. Citizens Defense Corps on their duties in gas defense have been issued by the U.S. Office of Civilian Defense in Operations Letter No. 104 (Supplement 3 to Operations Letter No. 42), dated January 11.

The duties to be performed before, during and after gas attacks are outlined for the following individuals and groups: State Gas Consultant, Senior Gas Officer, Assistant Gas Officers, Gas Reconnaissance Agents, Laundry Officer, Commander of the Citizens Defense Corps, Incident Officer, Air Raid Wardens, Police Services, Fire Services, Emergency Medical Service, Local Health Department, Public Works, Public Utilities, Transportation Services and Emergency Welfare Services.

Emergency Medical Service Functions

For the Emergency Medical Service the duties are set forth as follows:

Duties Before Gas Attack

1. Plan with assistance of Senior Gas Officer for the establishment of gas cleansing stations for cleansing gassed patients with other injuries and for cleansing of civilian protection personnel. Each hospital of 150 beds or more should be provided with a cleansing station. Cleansing stations should be available in the ratio of one per 50,000 population and should be located at smaller hospitals or casualty stations where 150-bed hospitals are not available in this ratio.

2. Recruit, train, and assign personnel to gas cleansing stations for cleansing services.

3. Provide instruction, in co-operation with the Senior Gas Officer, for general public and civilian protection personnel in self-protection and self-cleansing (Operations Letter 46).

4. Provide for instruction of physicians in diagnosis and treatment of chemical casualties.

5. Assist hospitals in planning for handling of gas casualties.

6. Assure adequate distribution of protective clothing and gas masks and other protective equipment to members of mobile medical teams and train personnel in their use.

7. Make provision for training drivers of ambulances and sitting case cars in protection of their equipment against liquid-gas contamination; inform them of arrangements for vehicle decontamination by Emergency Public Works Service.

8. Arrange for the protection from contamination of the equipment used to transport contaminated casualties insofar as it is possible.

Duties During Gas Attack

1. Upon advice of the Senior Gas Officer and under the orders of the Commander, man the gas cleansing stations.

2. Advise other services of the U.S. Citizens Defense Corps in regard to first-aid cleansing of their personnel.

3. Assign a mobile medical team to gas cleansing stations for first aid.

Duties After Gas Attack

1. Evaluate the effectiveness of the cleansing procedures which have been used.

2. Provide follow-up treatment of patients.

3. Prepare inventory of protective equipment available for use in future attacks and obtain additional equipment as necessary.

4. Cleanse bodies of the dead to facilitate identification.

Health Department Functions

Important functions assigned to the health department in the local program of gas defense are as follows:

Duties Before Gas Attack

1. Provide for analyses for war gases in samples of food and water. These tests may be performed in a local health department if laboratory facilities are adequate. In such case it is desirable to utilize the same laboratory facilities for the analysis for war gases of air and other materials. Where laboratory facilities other than those of the local health department are more suitable for use in the analysis of war gases, arrangements should be made by the local health department for the analysis of samples of water and food.

2. Advise the Senior Gas Officer regarding the nature of instructions to the public concerning precautions to be taken in the event of water-supply contamination. Such instructions are to be promulgated by the health officer.

3. Co-operate with water works officials in planning for the protection and decontamination of the water supply.

Duties During Gas Attack

1. Collect samples of food and water for laboratory analysis if contamination is suspected.

2. Inform the public regarding contamination of food and water supplies, including recommendations in regard to self-protection.

Duties After Gas Attack

1. Decontaminate, destroy, or otherwise provide for the handling and disposal of contaminated food supplies.

2. Assist the water works in the treatment of contaminated water supplies.

3. Advise the Senior Gas Officer in regard to the safety of the public water and food supplies and inform the public regarding contamination of such supplies, and methods of dealing with it.

4. Obtain reports of analyses of samples of water or food and take appropriate action. Save specimens of contaminated water and food for transmission whenever necessary to a Chemical Warfare Service or other laboratory, by the Senior Gas Officer.

Gas masks are now being distributed to the personnel of the protective services. As a guide to local distribution and care of masks, the U.S. Office of Civilian Defense issued Operations Letter No. 106, January 20.

It is recommended that masks be distributed among the protective services of the U.S. Citizens Defense Corps in approximately the following proportions: Staff, 12.5 per cent; Fire Service, 10.5; Police Service, 18.5; Air Raid Warden Service, 30; Rescue Service, 1.5; Medical Service, 12.5; Public Works, 9; and Public Utilities, 5.5.

Masks should be kept at the post where the protective personnel will assemble during drills or enemy action, not carried by them during their daily activities. It is recommended that about 20 per cent of the masks allocated to each service be stored as a reserve. It is important that the reserves be decentralized as a safeguard against destruction by fire or bombing and also to permit rapid distribution in case of an emergency.

The directive points out that since valuable and critical materials are used in the manufacture of gas masks, the utmost care must be exercised in the handling, distribution and storage. No person should receive a mask until he has been trained in its use and care, including proper storage.

Storage must be in a cool, dry place and masks should be kept from contact with sunlight, oils and corrosive liquids and vapors. After use, masks should not be worn by another individual without proper sterilization, instructions for which are given in the OCD publication "Protection Against Gas."

Repair of masks is not to be attempted locally except in extreme emergency. Broken, defective masks or those with exhausted canisters should be collected by the local Property Officer and returned to OCD Supply Depots for repair and replacement.

Classification of Utility Employees in Defense Corps

1. It is essential to the operation of the Citizens Defense Corps in emergencies that utility companies, and essential municipal services, including water, gas, electric, telephone, sewage, and sanitation, and others of a like classification, be able to function to the fullest extent both in maintaining service and in repairing damage caused by air raid or sabotage.

2. Therefore, essential operating employees of utility companies, including maintenance and repair personnel, executives and supervisory personnel, telephone operators, and those whose services are actually used in directing field operations, should be reserved for that purpose.

3. Employees such as those described in paragraph 2 above should not be referred by Volunteer Offices or assigned within the Citizens Defense Corps in a manner which would conflict with this primary and vital function. They should not, for example, be assigned as air raid wardens, auxiliary firemen, or auxiliary police, if at a time of air raid there would be necessity for their services in mobilizing and directing, or in participating in, protection against, or repair of, air raid damage.

4. Other employees of public utility companies, such as office employees, clerks, bookkeepers, statisticians, and the like, can best serve by volunteering their services through the local Civilian Defense Volunteer Office for referral to vacancies to which their talents are suited.

5. If there are at present essential or key operating or supervisory employees of utility companies or essential municipal services assigned to units of the Defense Corps other than the Utility Repair Units, they should be replaced by other volunteers at the earliest possible moment; and they should then take their places in the Utility Repair Units, or should reserve their time in case of air raid for operation at their stations.

6. Nothing in this Operations Letter should suggest that any employees of utility companies or essential municipal services may not volunteer for work in the Citizens Service Corps. The stated policy of the Office of Civilian Defense is that a volunteer may serve in both the Service Corps and the Defense Corps provided the assignment in the Service Corps does not interfere with his preparation and availability for adequate service in the Defense Corps.

7. The rule of reason should prevail. It is reasonable that highly skilled or technically trained individuals in each case should render the service that is hardest to replace.

Editorial Note: *A water department executive will consider his needs for emergency disaster personnel and train such office employees as are fitted for work in stations, etc.—before he approves their assignment to civilian defense activities not related to the water department.*

Operations Letter No. 96 (corrected January 25) to Regional Directors from James M. Landis, OCD Director.

Identification of Emergency Motor Vehicles

1. In order to facilitate the movement and provide for more adequate control of motor vehicles that should be permitted to move during periods of air-raid alarm (actual or test), the Office of Civilian Defense has determined to prescribe as Official Articles identifying devices that may be used by those vehicles which are classified as "Emergency Motor Vehicles." The use of the term "Essential Vehicles" is discontinued.

2. The primary identifying device shall be the Emergency Motor Vehicle pennants prescribed by Section 1 (g) of Supplementary Order No. 2 (revised October 23, 1942) to Office of Civilian Defense Regulations No. 2. A description of these pennants and the advantages of their use over other means of identification are set forth in detail in Operations Letter No. 97, issued December 8, 1942. Pennants should be mounted in an upright position at the forward left side of the vehicle and located so as to be visible from both sides without obscuring the vision of the driver.

3. Pending the approval and availability of a blackout driving lamp, Emergency Motor Vehicles should be further identified in periods of air-raid alarm during hours of darkness by the use over the right headlamp of a removable opaque mask prescribed as an Official Article by Amendment No. 1, February 4, 1943, to the aforesaid Supplementary Order No. 2 to OCD Regulations No. 2. Such mask shall embody the Civilian Defense basic insigne, $2\frac{1}{2}$ to 3 in. in diameter. The letters "CD" and the three segments of the surrounding circular field shall be trunslucent green and the triangle on which the letters "CD" are superimposed shall be opaque. This mask may be made of any suitable material that can be easily, quickly, and securely fastened to the right front headlamp. Motorcycles with one headlamp should attach the mask to a low-candlepower auxiliary lamp. The mask is intended for use where blackout regulations permit the use of headlamps. In coastal dimout areas it should be used in conjunction with dimout equipment.

4. The above-mentioned pennants and masks, embodying the patented and prescribed Civilian Defense basic insigne, are subject to Office of Civilian Defense Regulations No. 2 as to manufacture, sale, distribution, and use. Such pennants and masks may be used only by Emergency Motor Vehicles, which, for the purpose of determining eligibility to use such Official Articles, shall be defined as follows:

(a) Vehicles of the Armed Forces of the United States or her Allies and commercial or other vehicles acting under orders or traveling with express permission thereof;

(b) Vehicles of fire departments and governmental police agencies;

(c) Ambulances and official rescue cars and other vehicles converted to such use in emergency services;

(d) Public utility repair vehicles operating in emergency service;

(e) Vehicles in emergency service identified by insignia prescribed by the Director of Civilian Defense.

[Sections 5 to 14 of this letter give further information on the subject and may be consulted at the local OCD headquarters.]

Operations Letter No. 111 (Sup. No. 1 to Operations Letter No. 97,) issued February 11, 1943, to Regional Directors from James M. Landis, OCD Director.

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Subchapter B—Director General for Operations

Part 3175—Regulations Applicable to the Controlled Materials Plan

CMP REGULATION 5—MAINTENANCE, REPAIR AND OPERATING SUPPLIES

Editorial Note: The Controlled Materials Plan was set up by the WPB late in 1942 in an effort to co-ordinate uses of critical materials by basing as much of their allocation as possible (but not all) upon the distribution of raw materials rather than through authority to purchase finished units.

After the CMP procedure is in effect, authorizations to construct new water works plants or major additions to old ones will be entered in the WPB as a draft against the allocation of all critical materials allowed the Power Director. Already an estimate of the maintenance and repair requirements has been set up and taken into account in the Power Director's allocation.

See Administrative Letter on the preparation of Form CMP-4C for materials for construction or extensions, page 395 of this JOURNAL.

§ *3175.5 CMP Regulation 5*—(*a*) *Purpose and scope.* (1) The purpose of this regulation is to provide a uniform procedure for obtaining maintenance, repair and operating supplies, both in the case of controlled materials obtained by use of allotment symbols under the Controlled Materials Plan and in the case of materials or products obtained by preference ratings. Persons requiring maintenance, repair and operating supplies, in any form, in such quantities as are available from warehouses or distributors under CMP Regulation No. 4, or at retail without preference ratings or allotments, may obtain the same without using the procedure provided in this regulation but subject to all applicable limitations in War Production Board regulations and orders.

(*2*) The provisions of this regulation shall not apply to governmental agencies (other than Claimant Agencies) except to the extent that they may be engaged in one of the activities listed in Schedules I or II attached, and shall not apply to any person or institution, public or private engaged in educational, religious or charitable activities. Procedures for the obtaining of maintenance, repairs and operating supplies by such governmental agencies and by such persons and institutions will be provided by a separate regulation or order. This regulation is also inapplicable to certain

purchases by Claimant Agencies or for export as more fully provided in paragraph (g).

(b) *Definitions.* The following definitions shall apply for the purpose of this regulation, and for the purpose of any other CMP Regulation unless otherwise indicated.

(1) "Maintenance" means the minimum upkeep necessary to continue a facility in sound working condition, and "repair" means the restoration of a facility to sound working condition when the same has been rendered unsafe or unfit for service by wear and tear, damage, failure of parts or the like; *Provided,* That neither maintenance nor repair shall include the improvement of any plant, facility or equipment, by replacing material which is still usable, with material of a better kind, quality or design, except as provided in paragraph (b) (3) of this regulation.

(2) "Operating supplies" means any materials or products which are normally carried by a person as operating supplies according to established accounting practice and are not included in his finished product, except that materials included in such product which are normally chargeable to operating expense may be treated as operating supplies. The term shall also include such items as hand tools, customarily purchased by the particular employer for sale to his employees for use only in his business, in those cases where they would constitute operating supplies under established accounting practice if issued to employees without charge. The term shall not include any of the items specified in List A attached.

(3) In addition, there may be included as maintenance, repair and operating supplies, minor items of productive capital equipment and minor capital additions or replacements not exceeding $500 (excluding cost of labor); *Provided,* That no capital equipment, addition or replacement aggregating more than $500 in cost shall be subdivided for the purpose of coming within this definition, and, *provided further,* that the acquisition and use of materials for construction shall be subject to the provisions of Conservation Order L-41, as amended from time to time.

(4) Production materials required by a manufacturer for physical incorporation in his products, which products he sells for use as maintenance, repair or operating supplies, may be obtained as provided in CMP Regulation No. 1 and in CMP Regulation No. 3, and such production materials shall not be deemed maintenance, repair or operating supplies, as to such manufacturer.

(c) *Controlled materials.* (1) Subject to the quantity restrictions contained in paragraph (f) of this regulation, any person engaged in the business of producing any product or conducting any business listed in Schedule I or II, requiring delivery after March 31, 1943, of any controlled material, except aluminum, for maintenance, repair or operating supplies in the conduct of such business, may obtain the same by placing on his delivery order substantially the following certification, signed manually or as provided in Priorities Regulation No. 7:

CMP allotment symbol MRO—(P order No. ..). The undersigned certifies, subject to the criminal penalties for misrepresentation contained in section 35 (A) of the United States Criminal Code, that the controlled materials covered by this order are required for essential maintenance, repair or operating supplies, to be used for a purpose listed in Schedule I or Schedule II of CMP Regulation No. 5 and that delivery thereof

will not result in a violation of the quantity restrictions contained in paragraph (f) of said regulation.

When the person making such certification is covered by any order in the "P" series he shall also show, in the space indicated, the number of such "P" order.

An order bearing such certification shall be deemed an authorized controlled material order and shall have the same status as an order bearing an allotment number under all applicable CMP regulations, unless otherwise expressly provided.

(2) Any person engaged in the business of producing any product or conducting any business listed in Schedule I or II requiring aluminum in any of the forms or shapes constituting a controlled material, for essential maintenance, repair or operating supplies, may obtain the same from a controlled materials producer or from an approved aluminum warehouse, in amounts of not to exceed 100 pounds from all sources during any one calendar quarter, provided, that any order placed pursuant to this paragraph (c) (2) shall be accompanied by a certificate in substantially the following form, signed manually, or as provided in Priorities Regulation No. 7:

The undersigned certifies, subject to the criminal penalties for misrepresentation contained in section 35 (A) of the United States Criminal Code, that the materials covered by this order are required for essential maintenance, repair or operating supplies, to be used for a purpose listed in Schedule I or II of CMP Regulation No. 5; that the use of other materials for such purpose is impracticable; and that the amount of aluminum covered by this order, together with all other amounts received by, or on order for delivery to the undersigned, from all sources, for such purposes during the same quarter, will not exceed 100 pounds.

Any producer or warehouse receiving an order bearing such certificates shall be entitled to rely thereon and may fill the order, unless he knows or has reason to believe the certificate to be false.

(d) *Preference ratings for maintenance, repair and operating supplies.* (1) Subject to the quantity restrictions contained in paragraph (f) of this regulation, orders calling for delivery after March 31, 1943, of maintenance, repair or operating supplies other than controlled materials (regardless of whether such supplies be Class A products, Class B products, or other products or materials) are hereby assigned preference as follows:

(i) AA-1 for maintenance or repair of facilities required for producing any product or conducting any business listed in Schedule I or for necessary operating supplies for such production or business;

(ii) AA-2X for maintenance or repair of facilities required for producing any product or conducting any business listed in Schedule II or for necessary operating supplies for such production or business; and

(iii) A-10 for necessary maintenance or repair of facilities required for producing any product or conducting any business not listed in Schedule I or Schedule II or for necessary operating supplies for any such purpose.

(2) A preference rating assigned under this paragraph (d) shall be applied only by use of the following certification (in lieu of the endorsement specified in Priorities Regulation No. 3), signed manually or as provided in Priorities Regulation No. 7:

Preference Rating .... (specify rating)—MRO. The undersigned certifies, subject to the criminal penalties for misrepresentation contained in section 35 (A) of the United States Criminal Code, that the items covered by this order are required for essential maintenance, repair or operating supplies; that this order it rated and placed in compliance with CMP Regulation No. 5; and

that the delivery requested will not result in a violation of the quantity restrictions contained in paragraph (f) of said regulation.

(3) A person with whom a delivery order is placed bearing a preference rating assigned by this regulation may extend the rating only in the manner provided in Priorities Regulation No. 3 (using the endorsement therein specified) and subject to the limitations contained therein and in CMP Regulation No. 2.

(e) *Plants engaged in several activities.* If a single plant or operating unit is engaged in several activities which are not all listed on the same schedule (or if some are so listed and others are unlisted), and it is impracticable to apportion requirements for maintenance, repair and operating supplies between such activities the principal activity alone shall be considered for purposes of determining whether controlled materials may be obtained under paragraph (c) of this regulation and also for determining which preference ratings may be applied under paragraph (d).

(f) *Quantity restrictions.* (1) No person shall use the allotment symbol or preference ratings assigned by this regulation to obtain maintenance, repair or operating supplies during any calendar quarter in an aggregate amount exceeding one-fourth of his aggregate expenditures for maintenance, repair and operating supplies during the calendar year 1942 (or his fiscal year ending nearest to December 31, 1942), except that a person engaged in a seasonal business may use such allotment symbol or preference ratings to obtain during any calendar quarter, up to, but not in excess of, his aggregate expenditures for maintenance, repair and operating supplies during the corresponding quarter of 1942 (or of such fiscal year). In neither case, however, shall any person use such allotment symbol or preference ratings to obtain maintenance, repair and operating supplies during the 12 months ending March 31, 1944, in an amount exceeding his aggregate expenditures for maintenance, repair and operating supplies during the calendar year 1942 (or such fiscal year).

(2) A person who has several plants or other operating units which maintain separate records of maintenance, repair and operating supplies shall treat each of them separately for purposes of complying with the provisions of subparagraph (1) of this paragraph (f).

(3) In the case of a plant or other operating unit which was not in operation during the base period specified in subparagraph (1) of this paragraph (f), the person operating the same may take, as a base, his expenditures for maintenance, repair and operating supplies during the first quarter of 1943, or during the portion thereof when the plant or unit was in operation, reasonably adjusted for seasonal or other variable factors; provided, that he first notifies the War Production Board in writing of the base which he is taking, the reasons therefor, and the nature of any adjustments made. In the case of a plant starting operations after February 28, 1943, maintenance, repair and operating supplies may be acquired pursuant to this regulation in the minimum amounts necessary for operation, without other restrictions, up to $5,000 per quarter. If more than this amount is required, application shall be made in writing to the War Production Board for a specific quota. In any case where the base provided in subparagraph (1) or by this subparagraph (3) is deemed too low for necessary operations, application may be made in writing for modification thereof.

(4) The restrictions contained in this paragraph (f) shall apply in addition to any quantitative restrictions contained in any order in the "P" series, unless the particular P order expressly provides that the restrictions of this regulation shall be inapplicable.

(5) The Director General for Operations may, by further regulations or orders, require specified persons or classes of persons to file applications or reports regarding their requirements of maintenance, repair and operating supplies and may prescribe specific quantitative limits for the same, either larger or smaller than the limits provided above in this paragraph (f).

(g) *Special provisions for Claimant Agencies, exports and ship repairs.* Maintenance, repair and operating supplies, required either by a Claimant Agency (including any plant or establishment owned and operated by a Claimant Agency) or for export, as regular procurement items covered by specific programs, and material required for ship repairs programmed by the Maritime Commission, shall not be obtained under this regulation, but, if they are controlled materials or Class A products, shall be obtained only by the use of allotments in the same manner as production materials under CMP Regulation No. 1, and, if they are other materials or products, shall be obtained only by such preference ratings as may be specifically assigned for the purpose.

(h) *Penalties for misrepresentation or diversion.* (1) The placing of any order bearing a certification or symbol as provided by this regulation shall constitute a representation, subject to the criminal penalties of section 35 (A) of the United States Criminal Code (18 U.S.C. 80), that the person placing the order is entitled, under the terms of this regulation to use of the symbol or preference rating indicated thereon.

(2) No person shall use for any purpose other than essential maintenance, repair or operations, any supplies obtained pursuant to this regulation, or use any supplies obtained under a preference rating assigned by this regulation for a purpose to which a lower rating, or no rating, is assigned. Any such use shall constitute a crime punishable by fine or imprisonment or both. Physical segregation of inventories is not required, provided the restrictions applicable to any specific lot of material or product are observed with respect to an equivalent amount of the same material or product.

(i) *Inventory restrictions.* Nothing in this regulation shall be deemed to authorize any person to receive any delivery of maintenance, repair or operating supplies if acceptance thereof would increase his inventory above a practicable working minimum as provided in § 944.14 of Priorities Regulation No. 1 or would exceed the inventory limitations prescribed for such person by CMP Regulation No. 2, or by any other applicable regulation or order of the War Production Board.

(j) *Additional assistance in individual cases.* Any person requiring maintenance, repair or operating supplies who is unable to obtain them pursuant to the foregoing provisions of this regulation, may apply to the War Production Board for additional assistance on such form as may be appropriate, having regard to the material required and the business activity involved. If no particular form is specified by applicable orders or regulations of the War Production Board, such application may be made on Form PD-1A or, in the case of a PRP unit, on Form PD-25F. Such application may be filed with the appropriate In-

dustry Division, or, if the amount involved is less than $500, with the regional office of the WPB.

(k) *Effect on other orders and procedures.* (1) The preference ratings assigned by this regulation shall supersede the preference ratings assigned by all orders in the "P" series for maintenance, repair and operating supplies with respect to materials or products to be delivered after March 31, 1943, except as may be otherwise provided by amendments of such orders specifically providing to the contrary.

(2) Subject to paragraph (k) (1) of this regulation all of the terms, provisions and restrictions contained in all orders of the "P" series including definitions, requirements for making applications and filing reports, and other restrictions, except as otherwise provided in paragraph (f) (4) of this regulation, shall, subject to the inventory restrictions of CMP Regulation No. 2, remain in full force and effect until modified or revoked.

(3) In addition, each person who, in accordance with existing priorities procedures not covered by "P" orders, is required to file applications or reports with respect to his requirements for, or use of, maintenance, repair or operating supplies, or is limited in the amount or such supplies which he is permitted to acquire or use, shall continue to comply with such procedures until the same are modified or revoked.

(4) Nothing in this regulation shall be construed to relieve any person from complying with any applicable priorities regulation or order of the War Production Board (including orders in the "E," "L" and "M" series) or with any order of any other competent authority.

(l) *Industry reclassification.* Any person who is of the opinion that the business activity in which he is engaged should be listed in Schedule I, if it is listed in Schedule II, or should be listed in either Schedule I or Schedule II, if it is not listed in either of such schedules, may apply to have such activity so listed by filing a letter, in triplicate, with the appropriate Industry Division setting forth the relevant facts and the reasons why he considers such request should be granted.

(m) *Records.* Each person acquiring maintenance, repair or operating supplies pursuant to this regulation shall keep and preserve, for a period of not less than two years, accurate and complete records of all such supplies so acquired, and used, which shall, upon request, be submitted to audit and inspection by duly authorized representatives of the War Production Board.

(n) *Communications.* All communications concerning this regulation should be addressed to: War Production Board, Washington, D.C. Ref: CMP Regulation No. 5.

Issued this 9th day of February 1943.

CURTIS E. CALDER,
Director General for Operations.

List A

The following items are excluded from the definition of "operating supplies" in paragraph (b) (2) of CMP Regulation No. 5, regardless of whether normally carried as such according to established accounting practice:

1. Fabricated containers (in knock-down or set-up forms, whether assembled or unassembled), required for packaging products to be shipped or delivered
2. Printed matter and stationery
3. Paper, paperboard, and products manufactured therefrom; molded pulp products

4. Fuel or electric power

5. Office machinery or office equipment

6. Clothing, shoes or other wearing apparel, if made of leather or textiles, except that the following types may be included in operating supplies when specially designed and used to furnish protection against specific occupational hazards (other than weather):

a. Asbestos clothing

b. Safety clothing impregnated or coated for the purpose of making the same resistant against fire, acids, other chemicals or abrasives

c. Safety industrial rubber gloves and hoods and linemen's rubber gloves and sleeves

d. Gauntlet type welders' leather gloves and mittens, and electricians' leather protector or cover gloves

e. Other safety leather gloves or mittens but only if steel stitched or steel reinforced

f. Safety industrial leather clothing other than gloves or mittens

g. Metal mesh gloves, aprons and sleeves

h. Plastic and fibre safety helmets.

Schedule I—Preference Rating AA-1

Manufacture of the following:

Unfabricated and semifabricated products:

Aluminum and aluminum alloy semi-finished products
Copper and copper alloy semi-finished products
Ferro-alloys
Iron unfabricated and semifabricated products, including: forgings, pig iron, pipe, wire, wrought iron and foundry products
Magnesium and magnesium alloy semifabricated products
Nonferrous metal unfabricated and semifabricated products
Steel unfabricated and semifabricated products, including: bars, forgings, pipe, rolling mill and foundry products, sheets, strips, structural steel, tubing, and railroad rails, frogs, switches and crossings

Iron and steel finished products:

Aircraft landing mats
Boiler-shop products, including: boilers, gas cylinders, steam condensers, and tanks
Bolts
Cooking ranges and stoves, except electric
Fabricated pipe
Furnaces, including: heating stoves and related equipment
Hand tools, except farm and garden
Metal barrels, drums, kegs and shipping pails
Nuts
Rivets
Saws
Screws
Steel springs
Stove pipe
Thermostats and other temperature control devices
Transportation-equipment hardware
Washers
Water heaters, tanks and boilers

Chemical products:

Acids
Alcohols
Alkalies
Basic chemicals and intermediates
Coal tar and coal tar derivatives
Compressed and liquid gases
Dyes, colors, and pigments
Fats and oils (industrial only)
Lacquers
Organic and inorganic chemicals
Paints
Plastics and synthetic resins
Soap
Solvents
Varnishes

Industrial machinery and equipment:

Chemical manufacturing machinery and equipment
Compressors
Conveying machinery and equipment
Cranes, derricks, hoists and winches
Electric furnaces
Electrical industrial equipment
Excavating machinery
Fans and blowers (industrial)
Food-dehydration machinery
Furnaces and ovens (industrial)
Gas generating equipment and apparatus
Heat exchangers
Industrial lubricating equipment
Industrial machine-shop products
Industrial trucks and tractors
Instruments (industrial)
Machine tools and metal-working machinery, including: bending, forging, cutting, shearing, rolling, milling and pressing machinery
Mechanical power-transmission equipment
Mining machinery and equipment
Ore milling, smelting and refining equipment
Petroleum refining equipment

Plastic working machinery
Pumps
Rubber-working machinery
Stone, clay and glass products manufacturing machinery
Vacuum pumps
Welding equipment, gas and electric, including welding rods and electrodes
Well-drilling machinery
Woodworking machinery (except cooperage and wooden box making machinery)

Direct military products:
Aircraft, propellers, engines and parts
Ammunition
Ammunition boxes and chests
Combat vehicles
Explosives
Ordnance
Pyrotechnics
Ships, equipment and parts, including vessels of all types
Tanks, engines and parts (combat)

Electrical products:
Electrical carbon and graphite products
Electric motors and generators
Electrical instruments
Floodlights
Fuses
Insulated wire and cable
Motor-generator sets
Physical-therapy equipment
Pole-line hardware and insulators
Searchlights
Spotlights
Storage batteries
Switchgear
Transformers
Wiring devices and conduits
X-ray equipment

Engines and turbines:
Diesel engines
Gasoline engines
Hydro turbines
Steam engines and turbines

Communication equipment:
Communication equipment including telephone and telegraph systems and apparatus
Fire alarm systems
Phonographs
Radio and radar equipment and tubes
Railroad signals and accessories

Transportation equipment:
Bicycles and parts
Locomotives, diesel, electric and steam
Motorcycles, side cars and parts
Railroad and street cars

Miscellaneous products:
Abrasive wheels, stones, papers and cloths
Agricultural machinery, implements and equipment
Air-conditioning and commercial refrigeration equipment (mechanical)
Closures (pressed paper and molded plastic)
Elevators
Escalators
Fishing equipment (commercial)
Glass containers
Jewel bearings
Laundry equipment (domestic)
Motor vehicles, engines and parts (commercial)
Navigation instruments
Optical instruments and lenses
Photographic apparatus
Professional, scientific and engineering instruments and appliances
Refractories
Refrigerators (mechanical)
Rubber and rubber products (natural and synthetic)
Safety equipment, including helmets, goggles and civilian defense items
Stokers
Tires and tubes
Tractors
Valves, faucets and fittings
Wooden, paper and fiber containers

Persons engaged in the following industries:
Analytical, research, testing, and control laboratories
Discovery, production, transportation, refining and marketing of natural gas, petroleum and petroleum products
Electroplating, galvanizing and other metal coating
Gas, light, power, water, central heating, and sanitary services

[Water works superintendents will note their coverage in the item immediately above, whereas water works manufacturers will note various heads for different kinds of pipe or equipment in both Schedules I and II.]

Industrial food production, processing, packaging, preservation and storage
Mining and quarrying
Public transportation and terminal facilities including stevedoring
Ship repair and maintenance
Smelting
Wire communications industry

Schedule II—Preference Rating AA-2X

Manufacture of the following:

Iron and steel finished products:
Boilers and radiators (heating)
Cutlery
Fabricated iron and steel wire products
Gas conversion burners
Hardware except transportation-equipment hardware
Kitchen and household cans and pails
Lawn mowers
Metal bottle caps and closures, except beverage crowns
Metal cans
Metal doors, window sash, frames, molding and trim
Metal furniture
Metal sanitary ware
Milk cans (bulk)
Razors
Screens and weatherstripping
Steamtables and restaurant equipment
Tools, farms and garden
Vitreous enameled products

Non-ferrous metal products:
Clocks
Collapsible tubes
Insignia
Pins, needles, hooks, eyes, snaps, buckles and fasteners
Time stamps and recording machines
Watches

Non-metallic products:
Lumber, logs, ply-wood and veneer
Non-metallic sanitary ware
Textiles, clothing and leather goods

Industrial machinery and equipment:
Business machines
Construction material
Cooperage and box making machinery
Food-processing machinery and equipment, except dehydration equipment
Laundry and dry-cleaning equipment
Leather working machinery
Metal container making machinery
Printing machinery
Pulp and paper machinery
Scales
Spraying equipment (industrial)
Textile machinery
Water treatment equipment

Electrical products:
Dry cell batteries
Electric bulbs and tubes
Electric ranges
Electric sound signaling devices
Lighting fixtures

Fire protection equipment:
Fire engines
Fire extinguishers
Fire hose and related equipment
Hydrants and related equipment
Sprinkler systems

Transportation equipment:
Busses
Trailers (passenger-car)

Miscellaneous products:
Automotive testing equipment and instruments
Baby carriages
Church goods
Drugs and medicinals
Ice refrigerators
Mattresses and bed springs
Motion picture products
Musical instruments
Ophthalmic goods
Pens and pencils and related office supplies
Photographic accessories
Plumber specialties
Pulp and paper
Sewing machines
Signs
Umbrellas and parasols
Ventilating fans

Other products:
Other direct military products, manufacturing and construction equipment, components of products listed elsewhere, and other construction materials.

Persons engaged in the following industries:
Aeronautics training (civilian)
Civil air patrol
Commercial refrigeration and production of ice
Construction
Engraving on metal (except for printing)
Metal scrap salvage, sorting and processing of metal scrap
Printing and publishing
Public warehouses
Radio communication and broadcasting
Repair services for industrial and household equipment (motor and mechanical).

War Production Board

Administrative Letter to All Utilities—February 6, 1943

PREPARATION OF FORM CMP-4C, APPLICATION FOR ALLOTMENT OF CONTROLLED MATERIALS FOR CONSTRUCTION AND FACILITIES

Beginning with the second quarter of 1943, utilities and other industries will be able to secure materials and manufactured products under the Procedures of the Controlled Materials Plan (CMP).

Procedures for operating under CMP are described in CMP Regulations and Publications. CMP Regulation No. 1, although primarily applicable to manufacturing operations, outlines the basic procedures of applying for allotments of controlled material and of transmitting to suppliers the allotments received by the applicant. CMP Regulation No. 2 prescribes inventory restrictions, but it is expected that a directive under this Regulation will be issued whereby the inventory restrictions of Order P-46 instead will continue to apply to utilities. Other CMP Regulations cover preference ratings, transactions with warehouses and dealers, maintenance, repair, and operating supplies, and a regulation is in preparation pertaining to construction and facilities.

During the second quarter, suppliers may accept and fill orders for material when such orders carry preference ratings unaccompanied by CMP allotment numbers or allotment symbols, but orders accompanied by such CMP allotment numbers or allotment symbols will take precedence over other orders bearing the same rating and not accompanied by allotment numbers or symbols. After June 30, 1943, suppliers will not deliver controlled material and will in many cases refuse to fill orders for other material unless orders are accompanied by CMP allotment numbers or allotment symbols. Accordingly, it is decidedly to the advantage of utilities to avail themselves of CMP procedures with respect to deliveries needed during the second quarter and essential to do so with respect to deliveries needed thereafter.

Preference Rating Order P-46 is being amended to provide a simplified CMP procedure for obtaining material required for maintenance, repair, and operating supplies, including items required for construction projects or equipment for which the material cost does not exceed $1500 in the case of underground construction and $500 in the case of other construction and equipment. However, even within the $500 and $1500 limits, specific authorization will still have to be obtained to permit extensions of service lines.

In order to use CMP procedures to obtain material of any kind for construction projects or equipment for which the material cost is in excess of the $500 and $1500 limits, it is necessary for utilities to file application with the Power Division (except as otherwise directed) on Form CMP-4C. Form CMP-4C *must be used* in addition to Forms PD-200, PD-1A, PD-545, or a P-46 letter application.

A utility should list on Form CMP-4C, in the detail specified, the quantities of controlled material required for delivery from suppliers in each month after March 1943, including controlled material required in the manufacture of Class A * products. For example, if the project calls for delivery in November 1943 of a steam engine (a Class A product) for which the manufacturer needs to receive plates, bar stock, and tubing (controlled material) in June, July, and August, the utility should list the quantities needed by the engine manufacturer in those months. To carry the example a step further, if the engine manufacturer needs forgings (a Class A product) in July, to produce which, the forge shop requires billets (controlled material) in May, the utility should list the quantity needed by the forge shop in May.

The utility is not to include on Form CMP-4C any controlled material required for the manufacture of Class B products. Class B products incorporated into Class A products (for example, valves and pumps for a steam engine) are also to be excluded.

Wherever necessary the utility will obtain information from its suppliers as to the quantities of controlled material they will require in each month. This information will be furnished the utility on Form CMP-4C by contractors or suppliers doing work at the site and on Form CMP-4A by suppliers not doing work at the site (manufacturers of Class A products).

Form CMP-4C, if approved, will be returned to the utility with an allotment number, an allotment of controlled material, and a preference rating. The utility will apply the allotment number, allotment, and rating in the manner provided by CMP Regulations and instructions. The allotment number, allotment, and rating may not be used to obtain material of any kind for any purpose other than for the project authorized, and may not be used to obtain quantities larger than those authorized.

Form CMP-4C applications must cover only quantities of controlled material to be obtained from mills or dealers and must exclude quantities to be used from the utility's excess stocks or to be purchased from the excess stocks of another utility. In no case may a utility include on Form CMP-4C any quantities of controlled material which it has been directed to obtain from such excess stocks.

Form CMP-4C applications must carry an identification of the WPB authorization of the project (designation as to whether P-19, PD-1A, PD-545, PD-545B or P-46 letter, date, serial number and expiration date of P-19 orders, date and serial number of

---

* Detailed information concerning the Controlled Materials Plan can be obtained from your nearest WPB office. Briefly, the difference between Class A and Class B products is this: Class A includes basic *raw materials*, such as aluminum, copper, steel, etc.; Class B includes a large number of intermediate products, such as general industrial machinery and equipment, construction machinery and equipment, electrical machinery and apparatus, plumbing and heating equipment, etc.

PD-1A certificates, or date of PD-545A, PD-545B, or P-46 letter approvals). The identification must also include the preference rating assigned, if any. Each Form CMP-4C for construction started prior to April 1943 must be accompanied by a letter stating the following information:

1. For each type of controlled material (as listed in Form CMP-4C), a statement of the percentage of the total amount authorized for purchase from mills or dealers which it is estimated will have been delivered to the utility as of April 1.

2. Statement of the percentage of the total dollar value of the project which it is estimated will be installed as of April 1.

Form CMP-4C in connection with projects previously approved, in cases where the material cost exceeds the $500 and $1500 limits and a delivery of controlled material is required after March 31, should be prepared and submitted to the Power Division as soon as possible. Allotments to manufacturers under CMP will be made beginning in February and utilities are likely to find themselves at a disadvantage in securing delivery of orders after March 31 if their applications have not been received in time for allotments to be made concurrently with allotments to manufacturers.

Form CMP-4C in connection with projects approved hereafter should be prepared by the utility upon receipt of the construction authorization (except as noted below), if the material cost exceeds the $500 and $1500 limits and if a delivery of controlled material is required after March 31. Form CMP-4C shall be sent to the Power Division unless otherwise directed.

The Power Division intends to adopt the practice of preparing Form CMP-4C within WPB, in lieu of requiring preparation by utilities, in connection with applications submitted hereafter on PD-1A's or letters under P-46. Accordingly all PD-1A's or letter applications under P-46 submitted after receipt of this Administrative Letter should contain a statement of the month or months in which deliveries of controlled material will be required and such detailed description and weights of controlled material as will enable preparation of CMP-4C in our office. Until this practice is in operation, it will be necessary for utilities to prepare Form CMP-4C, in cases where it is required, after they receive approved PD-1A certificates or P-46 approval letters without an accompanying Form CMP-4C prepared by the Power Division.

Applications for approval of construction shall continue to be made on the same forms as in the past, and Form CMP-4C should not be submitted concurrently with the PD-200, PD-1A, PD-545 or P-46 applications.

Form CMP-4C is the only CMP form applicable to utilities at this time.

Very truly yours,
(signed)
HERBERT S. MARKS
Acting Director, Power Division
February 6, 1943

[The Instructions and the Forms for CMP-4C are available from your regional WPB office. These are also sold by certain printers. A.W.W.A. members can refer to the Instructions given herewith. They need obtain only the Forms, which are available from A.W.W.A. headquarters at 10¢ per set, 35¢ for 5 sets; 55¢ for 10 sets, and $2.50 for 50 sets. Stamps, cash or check must accompany such orders.]

Instructions for Making Applications for Allotment of Controlled Materials for Construction and Facilities

FORM CMP-4C

For Calendar Quarter April-June 1943

(This application is not to include requirements for maintenance, repair and operating supplies.)

Prime consumers and secondary consumers will prepare four legible copies of the application form unless otherwise directed. Each consumer will retain one copy for his files and submit the others as instructed.

Introduction

It is essential that you clearly understand the difference between a prime and a secondary consumer in order to submit your application correctly.

You are a prime consumer: (1) if you are the person for whom a construction of facility project is to be provided, or, (2) if you are the contractor employed by a Claimant Agency for a project to be provided for it.

A construction or facility project includes any building structure, industrial machinery, or equipment normally carried on your books as a capital addition in accordance with established accounting practices, exclusive of minor capital additions not exceeding in cost $500.00 for any one item which are treated as maintenance, repair or operating supplies. No capital addition aggregating more than $500.00 in cost shall be subdivided for the purpose of being treated as a maintenance, repair or operating supply.

You are a secondary consumer if and only if you provide any construction or facilities to a prime consumer or to another secondary consumer in connection with a project constituting a capital addition.

If you are a prime consumer you will obtain your allotment from a Claimant Agency.

If you are a secondary consumer you will obtain your allotment from the person to whom you directly provide any construction or facilities.

In illustration of the above principles—If A requires an addition to his plant and employs B, a building contractor, to construct the addition who in turn employs C, as a subcontractor, to perform part of the work—A is a prime consumer and both B and C are secondary consumers. A will obtain his allotment from a Claimant Agency, B will obtain his allotment from A, and C will obtain his allotment from B.

General

All consumers requiring steel, copper or aluminum, or Class A products, for any project must make application under the Controlled Materials Plan when directed either by general CMP regulations issued from time to time or by specific instructions from Claimant Agencies to prime consumers, from prime consumers to secondary consumers, or from secondary consumers to other secondary consumers.

Applications for controlled materials for construction and facilities must be

made on Form CMP-4C by prime consumers and by secondary consumers doing work at the site and must include all requirements for controlled materials as such and also for controlled materials necessary to produce Class A products to be incorporated in the project. However all applications from consumers *not* doing work at the site, for controlled materials for the production of Class A products to be incorporated in the project, shall be made on Form CMP-4A in accordance with the instructions applicable to such form.

Each applicant (whether a prime or secondary consumer) must furnish the appropriate application forms to his immediate contractor or subcontractors (including manufacturers of Class A products) and must obtain an application from each such contractor or subcontractor unless he is willing to furnish, on his own responsibility, information as to the contractor's or subcontractor's requirements, properly estimated, in which case no application need be obtained from such secondary consumers.

The application of each consumer must include the controlled materials required by himself and all secondary consumers who are to receive a portion of the controlled materials allotted to his authorized construction schedule.

Materials required for the manufacture of Class B products needed in connection with any project shall not be included in Form CMP-4C, or in Form CMP-4A.

Instructions for Filling out Form CMP-4C

1. *Show in the spaces provided in the heading:*

(a) The identifying "contract number" assigned by the War Production Board or transmitted to you on a purchase order by your customer. If none has been assigned or transmitted to you, write "None";

(b) The "Plancor number" assigned by Defense Plant Corporation. If none has been assigned, write "None";

(c) The "preference rating serial number," indicating the "date issued," assigned under applicable preference rating orders of the War Production Board. If none has been assigned, write "None";

(d) The "name, address and title of applicant's representative" to whom all communications connected with the application should be directed;

(e) The "major product or use of project" such as, for example:—"aircraft engine parts" or "generation of electric power";

(f) The "descriptive title" of the project such as, for example:—"Plant 3 Edgewood Arsenal" or "St. Anthony's Hospital";

(g) The "location" of the project;

(h) The "Claimant Agency or Industry Division," if any, principally concerned with the project; if none write "None";

(i) The "general contractor" employed by the prime consumer who is responsible for the project as a whole.

2. (*Section A*) *Construction schedule.*

If the information in this part of the form has not been inserted by an office of the War Production Board or by the consumer requesting the application, each consumer will prepare a construction schedule from the orders which his customer has placed with him with respect to the project covered by the application, or the latest construction schedule under which he has been advised to operate.

Show in the spaces provided in Section A:

(a) The "started or scheduled to start" date. For work in progress the actual starting date must be shown. For proposed projects, the estimated starting date must be shown;

(b) The "scheduled for completion" date, which must be the date on which it is estimated that the project will be completed;

(c) The "scheduled for initial operation" date, which must be the estimated date for initial operation or use of the project, even if the initial operation or use is limited.

3. (*Section B*) *Allotment, schedule authorization and preference rating:*

Applicants will leave this section blank in preparing applications. It is for the use of Claimant Agencies and consumers in making allotments. One copy of the form with this section filled in and certified will serve as authorization of construction schedule, authorization to purchase materials, and assignment of allotment number and preference rating. An allotment to a secondary consumer will carry the same allotment number and preference rating entered by the Claimant Agency on the allotment to the prime consumer.

4. (*Section C*) *Purchase schedule:*

Enter in columns (4), (6) and (8) the quantities of controlled materials required by you and your secondary consumers to complete the construction schedule. These quantities should represent the amounts to be scheduled for shipment to you and your secondary consumers in the months shown. Materials needed for maintenance, repair, and operating supplies or for Class B products must not be included.

For Steel, enter net tons of carbon steel (including wrought iron) and net tons of alloy steel, without regard to individual shapes or forms. Wire nails have been designated as a form of controlled material and therefore should be included as carbon steel requirements.

For Copper, enter the pounds of each of the nine classifications indicated in the form. Note that in requesting copper base alloys you are to show the total weight of brass or other alloys.

For Aluminum, enter the pounds of each of the eight classifications indicated in the form. The Aluminum Division will provide consumers requiring forgings, pressings, or impact extrusions with a special application form showing a more detailed breakdown of the total shown for these products in CMP-4C.

It is the responsibility of each applicant to plan his purchase schedules so that at no time will his inventories exceed those permitted under WPB regulations or orders. If an applicant files more than one form CMP-4C he may apportion his inventories to projects in any way that is convenient. He is held responsible only for his total inventory in relation to his total requirements for all projects.

Col. (5), (7) *and* (9). These are to be left blank by the applicant, and will be used by the Claimant Agency or customer, when the form is certified, to enter allotments of materials in accordance with CMP regulations.

Form CMP-4C (12-31-42)

UNITED STATES OF AMERICA
WAR PRODUCTION BOARD

Bureau of the Budget No. 12-R791-42
Approval Expires March 31, 1943

APPLICATION FOR ALLOTMENT OF CONTROLLED MATERIALS FOR CONSTRUCTION AND FACILITIES

	CONTRACT NUMBER
	PLANCOR NUMBER
ENTER BELOW NAME AND ADDRESS OF CLAIMANT AGENCY OR COMPANY TO WHICH APPLICATION IS MADE	PREFERENCE RATING SERIAL NUMBER DATE ISSUED
NAME AND ADDRESS OF APPLICANT	NAME, ADDRESS, AND TITLE OF APPLICANT'S REPRESENTATIVE

IDENTIFICATION OF PROJECT

COPY

MAJOR PRODUCT OR USE OF PROJECT	
DESCRIPTIVE TITLE OF PROJECT	LOCATION
CLAIMANT AGENCY OR INDUSTRY DIVISION	GENERAL CONTRACTOR

Section A.—CONSTRUCTION SCHEDULE

ITEM	DATE	
	MONTH	YEAR
STARTED OR SCHEDULED TO START		194
SCHEDULED FOR COMPLETION		194
SCHEDULED FOR INITIAL OPERATION		194

COPY

Section B.—(To be left blank by applicant)

ALLOTMENT, SCHEDULE AUTHORIZATION, AND PREFERENCE RATING

The quantities of controlled materials specified by months below and on the reverse side of this sheet in columns are hereby allotted to the above-named consumer for purchase by him and/or his secondary consumers for the period ending in connection with the above production schedule which is authorized. The preference rating indicated below is assigned (or applied or extended) to said construction schedule. Use of the rating and allotment number are subject to applicable War Production Board regulations.

ALLOTMENT No. ☐ (Agency) ☐☐☐☐ (Program number) ☐☐☐ (Authorized schedule) X X (Month number)

A complete allotment number consists of the Claimant Agency, program number, authorized schedule and month number. The month number, left blank above, is shown opposite the appropriate month in column (3) in the Purchase Schedule.

ASSIGNED PREFERENCE RATING: ____________

COPY

____
(Name of Claimant Agency or consumer making allotment)

______________ (Date)   ______________________ (Authorized official)

War Board 5880—p. 1

Printed below and on the reverse side of this application are the Purchase Schedules for Steel, Copper, and Aluminum. Show as your requirements the quantities of controlled materials which must be scheduled for shipment each month to you and to your secondary consumers by suppliers so that you can meet the tentative production schedule shown above.

Section C.—PURCHASE SCHEDULE

	Month	Year	Month No.	STEEL PRODUCTS (TONS, 2000 POUNDS) Carbon Required	Carbon Allotment (leave blank)	Alloy Required	Alloy Allotment (leave blank)	LEAVE BLANK
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	April	1943	16					
	May	1943	17					
	June	1943	18					
	July	1943	19					
	Aug.	1943	20					
1	Sept.	1943	21					
	Oct.	1943	22					
	Nov.	1943	23					
	Dec.	1943	24					
	Jan.	1944	25					
	Feb.	1944	26					
	Mar.	1944	27					

	Month	Year	Month No.	BRASS MILL COPPER BASE ALLOY PRODUCTS (TOTAL POUNDS OF ALLOY) 3011. Sheet and Strip Other Than Cups and Discs Required	3011. Allotment (leave blank)	3021. Rods, Bars, and Wire, Including Extruded Shapes Required	3021. Allotment (leave blank)	3041. Tubing and Pipe Required	3041. Allotment (leave blank)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	April	1943	16						
	May	1943	17						
	June	1943	18						
	July	1943	19						
	Aug.	1943	20						
2	Sept.	1943	21						
	Oct.	1943	22						
	Nov.	1943	23						
	Dec.	1943	24						
	Jan.	1944	25						
	Feb.	1944	26						
	Mar.	1944	27						

	Month	Year	Month No.	BRASS MILL COPPER PRODUCTS (POUNDS) 3051. Plate, Sheets, and Strip Required	3051. Allotment (leave blank)	3061. Rods, Bars, and Extruded Shapes Excluding Wire Bars and Ingot Bars Required	3061. Allotment (leave blank)	3071. Tube and Pipe Required	3071. Allotment (leave blank)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	April	1943	16						
	May	1943	17						
	June	1943	18						
	July	1943	19						
	Aug.	1943	20						
3	Sept.	1943	21						
	Oct.	1943	22						
	Nov.	1943	23						
	Dec.	1943	24						
	Jan.	1944	25						
	Feb.	1944	26						
	Mar.	1944	27						

War Board 3380—p. 2

Section C.—PURCHASE SCHEDULE—Continued

Month (1)	Year (2)	Month No. (3)	WIRE MILL COPPER PRODUCTS (POUNDS) — 3101. Wire and Cable, Including Copper Content of Insulated Wire and Cable — Required (4)	Allotment (leave blank) (5)	FOUNDRY COPPER AND COPPER BASE ALLOY PRODUCTS (POUNDS) — 3201. Castings — Required (6)	Allotment (leave blank) (7)	LEAVE BLANK
April	1943	16					
May	1943	17					
June	1943	18					
July	1943	19					
Aug.	1943	20					
4 Sept.	1943	21					
Oct.	1943	22					
Nov.	1943	23					
Dec.	1943	24					
Jan.	1944	25					
Feb.	1944	26					
Mar.	1944	27					

ALUMINUM PRODUCTS (POUNDS)

Month (1)	Year (2)	Month No. (3)	Rod, Bar, Wire and Cable (4021-4121, 4151) — Required (4)	Allotment (leave blank) (5)	Rivets (4122) — Required (6)	Allotment (leave blank) (7)	Forgings, Pressings, and Impact Extrusions (4171 and 4701) — Required (8)	Allotment (leave blank) (9)
April	1943	16						
May	1943	17						
June	1943	18						
July	1943	19						
Aug.	1943	20						
5 Sept.	1943	21						
Oct.	1943	22						
Nov.	1943	23						
Dec.	1943	24						
Jan.	1944	25						
Feb.	1944	26						
Mar.	1944	27						

ALUMINUM PRODUCTS (POUNDS)

Month (1)	Year (2)	Month No. (3)	Castings (4202-4218) — Required (4)	Allotment (leave blank) (5)	Shapes, Rolled or Extruded (4251, 4301, and 4311) — Required (6)	Allotment (leave blank) (7)	Sheet, Strip, Plate, and Foil (4351, 4361, and 4601) — Required (8)	Allotment (leave blank) (9)
April	1943	16						
May	1943	17						
June	1943	18						
July	1943	19						
Aug.	1943	20						
6 Sept.	1943	21						
Oct.	1943	22						
Nov.	1943	23						
Dec.	1943	24						
Jan.	1944	25						
Feb.	1944	26						
Mar.	1944	27						

Section C.—PURCHASE SCHEDULE—Continued

Month (1)	Year (2)	Month No. (3)	ALUMINUM PRODUCTS (POUNDS) Tubing (4401 and 4411) Required (4)	Allotment (leave blank) (5)	Ingot and Powder (4601, 4801 and 4811) Required (6)	Allotment (leave blank) (7)	LEAVE BLANK
April	1943	16					
May	1943	17					
June	1943	18					
July	1943	19					
Aug.	1943	20					
7 Sept.	1943	21					
Oct.	1943	22					
Nov.	1943	23					
Dec.	1943	24					
Jan.	1944	25					
Feb.	1944	26					
Mar.	1944	27					

The undersigned certifies to the above-named claimant agency (and, if application is made to a company, to such company) that, to the best of his knowledge and belief, the information contained in this application is correct and complete and has been prepared in accordance with the instructions for preparing CMP-4C, with which the undersigned is familiar.

(Name of company)

(Date)

(Signature of authorized official)

Section 35 (A) of the United States criminal code, 18 U. S. C., Sec. 80, makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

War Board 3380—p. 4

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Subchapter B—Director General for Operations

Part 3176—Valves and Valve Parts

LIMITATION ORDER L-252

The fulfillment of requirements for the defense of the United States has created a shortage of steel, copper, and other critical materials used in the manufacture of valves and valve parts, for defense, for private account, and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense:

§ 3176.1 *Limitation Order L-252*

(a) *Definitions.* Wherever used in this order:

(1) "Producer" means any person who manufactures valves and valve parts.

(2) "Valves" means gate, globe, angle, cross, lift check, angle check, or swing check valves (including variations of those types, such as the valves generally referred to as quick opening, blow off, hose end, Y-type and hydraulic), except drilling through and flow line valves for oil production service. This definition does not include valves of the types generally referred to as "specialties."

(3) "Valve parts" means parts for valves as defined above.

(4) "Put into process" means to process, machine, or fabricate or in any other manner alter any material by physical or chemical means.

(b) *Limitations.* Except as specifically authorized by the Director General for Operations, no producer shall after May 1, 1943, put into process or cause to be put into process, any material to be incorporated into valves or valve parts, except for the manufacture of valves and valve parts which conform to the specifications contained in the Appendix attached to and a part of this order, or for the manufacture of:

(1) Valves

(i) The bodies or bonnets of which were cast before May 1, 1943;

(ii) Ordered for use as part of the equipment of aircraft or watercraft other than pleasure craft; or

(iii) For the conduction of liquid or gas having chemical or physical properties which render the use of valves described in the Appendix dangerous or impractical; and

(2) Valve parts for repair of valves which are completed on May 1, 1943, or which are produced thereafter in accordance with the provisions of paragraph (b) (1) of this order.

(c) *Restricted deliveries.* Except as specifically authorized by the Director General for Operations:

(1) No producer shall sell or make delivery of any valves or valve parts manufactured in violation of the terms of this order, and

(2) No person shall knowingly purchase or accept delivery of any valve or valve part produced in violation of this order.

(d) *Order superseded.* The provisions of this order supersede the provisions of Schedule No. 1 of Limitation Order L-42.

(e) *Applicability of priorities regulations.* This order and all transactions affected thereby are subject to the provisions of all applicable priorities regulations.

(f) *Records.* Each producer shall retain in his files for a period of two years records showing his inventory and production of all valves, including those for the manufacture of which material was put into process subsequent to May 1, 1943. These records shall be kept readily available and open to inspection by duly authorized representatives of the War Production Board.

(g) *Appeals.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate referring to the particular provision appealed from and stating fully the grounds of the appeal.

(h) *Violations.* Any person who wilfully violates any provision of this order or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States, is guilty of a crime, and upon conviction, may be punished by fine or imprisonment or both. In addition any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control, and may be deprived of priorities assistance.

(i) *Communications.* All reports required to be filed hereunder and all communications concerning this order shall, unless otherwise directed, be addressed to: Shipbuilding Division, War Production Board, Washington, D.C., Ref.: L-252.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 23rd day of January 1943.

(signed)
ERNEST KANZLER
Director General for Operations

APPENDIX—SPECIFICATIONS FOR VALVES AND VALVE PARTS

The following specifications govern the manufacture of valves and valve parts. These specifications do not purport to contain any recommendations regarding the most efficient or safe use of any valve or valve parts covered herein.

Certain of the terms used in this appendix (including the terms valves and valve parts) are defined in the body of this order, L-252. In addition, certain exceptions are made, and certain obligations imposed upon producers and others. You should, therefore, be thoroughly familiar with the body of the order before reading this appendix.

Part 1—Iron Gate, Globe, Angle, Cross, and Check Valves and Valve Parts

1. *Standard size schedule: Iron valves.* (a) Valves shall be manufactured only in the pressure classes listed in Table 1 and in the particular sizes, specified in Table 2, which are comprehended within the size range specified in Table 1 for the particular pressure class.

TABLE 1 [OF PART 1]

(All size ranges are inclusive)

Primary [1] Pressure Classifications		Gates			Globe and Angle		Lift Check		Swing Check		
Steam	Water	Screwed	Flanged	Hub	Screwed	Flanged	Screwed	Flanged	Screwed	Flanged	Hub
psi.	*psi.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
25....	50	—	4 to 72	4 to 72	—	—	—	—	—	—	—
	100	—	4 to 72	4 to 72	—	—	—	—	—	—	—
125....	150 to 200	2 to 6	2 to 72	2 to 72	2 to 4	2 to 10	2 to 4	3 to 6	2 to 6	2 to 24	4 to 24
150 [2]...	250	¼ to 3 [2]	1 to 3 [2]	—	¼ to 3 [2]	1 to 3 [2]	¼ to 3 [2]	—	¼ to 3 [2]	—	—
250....	500	2 to 4	2 to 24	—	2 to 4	2 to 6	—	—	2 to 4	2 to 12	—
300 [2]...	—	¼ to 3 [2]	1 to 3 [2]	—	¼ to 3 [2]	1 to 3 [2]	—	—	¼ to 3 [2]	—	—
	800	2 to 6	3 to 12	—	—	—	—	—	—	3 to 12	—

[1] The primary pressure classification designates a class of valves and does not necessarily mean that all sizes in a given class carry the primary pressure classification. American Standards Association standards and manufacturers practice frequently reduce the pressure ratings as size increases, and may not always rate valves for both steam and water.

[2] In sizes 3 in. and smaller the 150 psi. and 300 psi. primary pressure classification valves are included as substitutes for brass valves. Flanged valves may be rated in accordance with the American Flange Standard used.

TABLE 2 [OF PART 1]

(Sizes in inches)

¼	4	24
⅜	5	30
½	6	36
¾	8	42
1	10	48
1¼	12	54
1½	14	60
2	16	66
2½	18	72
3	20	

NOTE: Other valve end connections in common use on the date of issuance of this order, including among others, the types known as Victaulic, Dresser, and Universal, may be manufactured, but only in accordance with the specifications listed in Table 1. For the purposes of this order, "common use" means use by at least ten companies.

(b) Detail of permitted sizes (see 1 (a) above).

2. *General requirements for iron valves.* (a) End flanges shall conform to American Standards Association standards for corresponding pressure classes, except that for 150 psi. and 300 psi. valves when made of malleable iron as substitutes for brass valves, flanges conforming to Manufacturers Standardization Society of the Valve and Fitting Industry Bronze Flange Standard SP-2 may be used. Flanges may be furnished to the American Gas Association flange standard for low pressure gas service.

(b) Face to face of flanged valves, size 4 in. and larger, shall comply with American Petroleum Institute standard #5-G-1 and American Standards As-

sociation standard B-16.10 for the pressure classes and types which these standards cover.

(c) Valves for 150 psi. primary steam rating and lower shall have manufacturer's standard seating materials, comprising any of the following:

Non-metallic disc
Iron or carbon steel
Brass or bronze
Nickel alloy

(d) Valves for 250 psi. primary steam rating and higher shall have manufacturer's standard seating materials, comprising any of the following:

Non-metallic disc
Iron or carbon steel
Brass or bronze
Chrome iron

(e) Bonnet bolts or studs shall be carbon steel.

(f) Nuts for bonnet bolting shall be carbon steel.

(g) Handwheels shall be of ferrous metal, either cast or otherwise fabricated, or of suitable non-metallic material.

(h) All extension stems, couplings and gear housings shall be of ferrous metal.

(i) Spot facing or back facing on iron valve flanges is prohibited except when necessary to prevent scrapping otherwise usable products.

3. *Iron gate valves.* (a) Stems for outside screw and yoke valves shall be, at manufacturers' option, either of carbon steel, or of brass or bronze made from secondary metal, i.e., copper base alloy to which refined copper or refined tin is not added in the production of the castings for the stems.

(b) Discs for solid wedge gates 4 in. and larger and for split wedge or double disc gates 5 in. and larger, shall be all iron or iron with faces conforming to paragraphs 2 (c) or 2 (d) depending upon pressure class. Discs for non-rising stem valves may be provided with brass or bronze bushing for stem thread.

(c) Bonnet bushing for backseating shall not be provided in outside screw and yoke valves.

(d) Packing gland flange bolts or studs shall be carbon steel.

(e) Nuts for packing gland flange bolts or studs shall be carbon steel.

(f) For valves 4 in. and larger, the packing gland, if flange and follower or nose are one piece, shall be of iron or iron brass bushed; or if made of two pieces, the flange shall be iron and the follower or nose may be brass.

4. *Iron globe, angle, and cross valves.* (a) "Plug" type discs shall not be used for primary pressure 125 psi. classification; but no manufacturer shall make more than one design of metal to metal seat in this class.

(b) Discs for valves 4 in. and larger shall be all iron or iron with faces conforming to paragraphs 2 (c) or 2 (d) depending upon pressure class.

(c) Stems for outside screw and yoke valves shall be, at manufacturers' option, either of carbon steel, or of brass or bronze made from secondary metal, i.e., copper base alloy to which refined copper or refined tin is not added in the production of the castings for the stems.

(d) Bonnet bushing for back seating shall not be provided.

(e) Packing gland flange bolts or studs shall be carbon steel.

(f) Nuts for packing gland flange bolts or studs shall be carbon steel.

(g) For valves 4 in. and larger, the packing gland, if flange and follower or nose are one piece, shall be of iron or iron brass bushed; or if made of two pieces, the flange shall be iron and the follower or nose may be brass.

(h) Cross valves shall not be manufactured.

5. *Iron check valves.* (a) Discs for valves 4 in. and larger shall be either all iron, or iron or steel with faces conforming to paragraphs 2 (c) or 2 (d) depending upon pressure class.

(b) Nuts for attaching swing check disc to hinge or arm shall be carbon steel, or malleable iron.

(c) The hinge or arm for valves 2 in. and larger shall be of ferrous metal and may be bronzed bushed.

Part 2—Brass or Bronze Gate, Globe, Angle, Cross, and Check Valves and Valve Parts

1. *Standard size schedule: Brass or bronze valves.* (a) Valves shall be manufactured only in the pressure classes listed in Table 1, and in the particular sizes specified in Table 2, which are comprehended within the size range specified in Table 1 for the particular pressure class.

TABLE 1 [OF PART 2]

(All size ranges are inclusive)

Primary Pressure Classifications [1]	Sizes [2] Screwed End	Sizes Flanged End	Sizes Solder End
psi.	*in.*	*in.*	*in.*
100 Steam....	1/8 to 2	—	3/8 to 2
125 Steam....	1/8 to 2	—	1/4 to 2
150 Steam....	1/8 to 2	1 to 2	1/4 to 2
200 Steam....	1/8 to 2	1 to 2 [3]	1/4 to 2
300 Steam....	1/4 to 2	1 to 2	1/4 to 2
Hydraulic 1000 and Higher.....	1/8 to 2	—	1/4 to 1 1/2

[1] The primary steam rating in no way regulates the pressure at which these valves should be rated for other fluids, but restricts the classes to those mentioned.

[2] Only globe and angle valves may be made in the 1/8" size.

[3] These valves are rated 150 psi.

(b) Detail of permitted sizes (see 1 (a) above).

TABLE 2 [OF PART 2]

(Size in inches)

1/8	1/2	1 1/4
1/4	3/4	1 1/2
3/8	1	2

2. *General requirements for brass or bronze valves.* (a) Check valves shall be horizontal lift and vertical lift or swing check types only. Angle type prohibited.

(b) Spot facing on end connecting flanges is prohibited.

(c) 150 psi. primary pressure classification and lower shall have integral seats.

(d) 150 psi. primary pressure classification and lower shall have brass, bronze, or non-metallic disc only, and plug type discs shall not be used in globe and angle valves.

(e) 200 psi. primary pressure classification and higher shall have manufacturer's standard seating materials comprising any of the following:

Non-metallic disc
Brass or bronze
Chrome iron
Nickel alloy

(f) Union bonnet rings and union rings for valve ends shall be malleable iron or steel.

(g) Stuffing box packing nuts shall be malleable iron or steel.

(h) Handwheels and valve handles shall be ferrous metal, either cast or otherwise fabricated; or suitable non-metallic material.

(i) End flanges shall conform to:

1. Manufacturers Standardization Society of the Valve and Fittings Industry, Standard Practice 150 psi.-SP-2.

2. Manufacturers Standardization, Society of the Valve and Fittings Industry, Standard Practice 300 psi.-SP-2.

(Depending upon rated pressure of the valve.)

(j) Use Manufacturers Standardization Society of the Valve and Fittings Industry, SP-20 grade A or American Society for Testing Materials B-62 or EA-B62 brass or bronze for all valve pressure castings in valves in primary pressure classifications of 125 psi., 150 psi. and 200 psi. Use Manufacturers Standardization Society of the Valve and Fittings Industry, SP-20 grade B or American Society for Testing Materials B-61 brass or bronze for all valve pressure castings in valves in primary classifications of 300 psi. or higher. Bonnets 200 psi. and higher pressure classification may be made of a "cast bearing bronze."

(k) Cross valves shall not be manufactured.

Part 3—Steel Gate, Globe, Angle, Cross, and Check Valves and Valve Parts

NOTE: These limitations do not apply for primary ratings higher than 1500 psi. Moreover, these limitations do not apply for valves for temperatures exceeding 1000°F. or below minus 50°F. Furthermore, these limitations do not apply to drilling through or flow line valves for oil production service.

The term "stainless" is used in this Part 3 of this appendix to describe any of the iron base alloys such as 12 per cent chrome, or 18–8 chrome nickel whose primary characteristics are resistance to corrosive attack, or elevated temperature, or both.

1. *Standard size schedule: Steel valves.* (a) Valves shall be manufactured only in the pressure classes listed in Table 1, and in the particular sizes specified in Table 2 which are comprehended within the size range specified in Table 1 for the particular pressure class.

TABLE 1 [OF PART 3]

(All size ranges are inclusive)

Primary Pressure Classification	Gate		
	Screwed	Flanged	Welded
psi.	*in.*	*in.*	*in.*
150	2 to 4	2 to 24	—
300	2 to 4	2 to 24	—
600	¼ to 2	½ to 24	¼ to 24
900	—	3 to 18	3 to 18
1500	¼ to 2	1½ to 14	¼ to 14
	Globe and Angle		
	Screwed	Flanged	Welded
	in.	*in.*	*in.*
150	2 to 4	2 to 8	—
300	2 to 4	2 to 12	—
600	⅛ to 2	½ to 14	⅛ to 14
900	—	3 to 14	3 to 14
1500	¼ to 2	1½ to 14	¼ to 14
	Horizontal and Angle Check		
	Screwed	Flanged	Welded
	in.	*in.*	*in.*
150	—	—	—
300	—	2 to 8	—
600	¼ to 2	½ to 14	¼ to 14
900	—	3 to 14	3 to 14
1500	¼ to 2	1½ to 14	¼ to 14
	Swing Check		
	Screwed	Flanged	Welded
	in.	*in.*	*in.*
150	2 to 4	2 to 8	—
300	2 to 4	2 to 12	—
600	½ to 2	1¼ to 14	1¼ to 14
900	—	3 to 14	3 to 14
1500	—	3 to 14	3 to 14

(b) Detail of permitted sizes. [See Table 2.]

2. *General requirements for steel valves.* (a) Valves covered by items 3, 4, and 5, which follow, shall be in accordance with American Petroleum Institute standard 600A for gate valves, and with American Standards Association B16e for all types, except as modified by the specifications set forth in this part 3 of this appendix.

(b) Face to face of flange end valves shall comply with American Petroleum Institute standard 5-G-1 and American Standard Association B16.10 for the types covered by these standards.

(c) Discs of valves 5 in. and larger shall be made of the same material as the valve body, with seating material laid on or attached.

TABLE 2 [OF PART 3]

(Sizes in inches)

1/8	2	10
1/4	2 1/2	12
3/8	3	14
1/2	4	16
3/4	5	18
1	6	20
1 1/4	8	24
1 1/2		

(d) Handwheels 24 in. diameter and smaller shall be malleable iron, or fabricated steel.

(e) Raised contact faces on flanges shall be serrated (concentric or spiral) or smooth at manufacturer's option.

(f) Cross valves shall not be manufactured.

3. *150-psi. Pressure class: Steel valves.* (a) End flange faces shall have American Standards Association $\frac{1}{16}$ in. raised face.

(b) Bodies and bonnets shall be carbon steel. For minus 50°F. (sub-zero service), carbon steel shall be heat treated to give impact value of 10 ft.lb. minimum Charpy keyhole at minus 50°F.

(c) Seating materials shall be any of the following:

Carbon steel
Brass or bronze
12 per cent chrome iron

(d) Bonnet bushing for backseating shall not be provided, but backseating shall be included.

(e) Stems shall be carbon steel, brass or bronze.

(f) Bonnet bolting shall be carbon steel having physical properties equal to American Society for Testing Materials A96, Class A, except that when carbon steel having Class A physicals is not obtainable, manganese steels of the SAE 1300 Series or equal may be used.

(g) Bonnet bolt nuts shall be semi-finished carbon steel.

(h) Steam stuffing box packing shall be graphite or mica-impregnated asbestos according to manufacturer's practice.

(i) Bonnet gaskets shall be asbestos composition sheet.

4. *300-psi. Pressure class: Steel valves.* (a) End flange faces shall be American Standards Association $\frac{1}{16}$ in. raised face, or American Petroleum Institute octagonal ring joint groove providing the groove is cut in the basic flange thickness.

(b) Bodies and bonnets shall be carbon steel, except when required to resist extreme corrosion or temperature conditions they may be 4 per cent to 6 per cent chrome, $\frac{1}{2}$ per cent molybdenum. For minus 50°F. (sub-zero service), carbon steel shall be treated to give impact value of 10 ft.lb. minimum Charpy keyhole at minus 50°F.

(c) The seating materials shall be any of the following:

Same material as body
Brass or bronze
12 per cent chrome iron
Nickel copper alloy
Hard facing

(d) Stems shall be any of the following:

Brass or bronze
12 per cent chrome iron

(e) Stem stuffing box packing shall be graphite or mica-impregnated asbestos according to manufacturer's practice.

(f) Bonnet bolting shall conform to the following limitations:

1. For temperatures up to and including 850°F., National Emergency 9400 series steels or SAE 4140, heat treated to meet specifications for alloy steel bolting material for high temperature service, American Society for Testing Materials A96, Class B physical properties minimum.

2. For temperatures over 850°F., Grade B14 steel per American Society for Testing Materials A193, heat treated to meet specifications for alloy steel bolting material for high temperature service, American Society for Testing Materials A96, Class C physical properties minimum.

(g) Bonnet bolt nuts shall be semi-finished carbon steel, normalized or quenched.

5. *600-, 900- & 1500-psi. Pressure classes: Steel valves.* (For 600- and 1500-psi. general purpose valves, see paragraph 6.) (a) End flange faces shall be either American Standards Association octagonal ring joint groove or American Petroleum Institute octagonal ring joint groove, or ¼ in. American Standards Association large male face.

(b) Bodies and bonnets shall be carbon or carbon molybdenum steel, except when required to resist extreme corrosion or temperature conditions, in which case they may be 4 per cent to 6 per cent chrome, ½ per cent molybdenum, or stainless if so specified. (See definition for "stainless" in note under heading of Part 3.)

(c) The seating materials shall be of any of the following:

Same material as body
Stainless (See definition in note under heading of Part 3)
Nickel copper alloy
Hard facing

(d) Stems shall be the following:

Stainless (See definition in note under heading of Part 3)

(e) Stem stuffing box packing shall be graphite or mica-impregnated asbestos according to manufacturer's practice.

(f) Bonnet bolting shall conform to the following limitations:

1. For temperatures up to and including 850°F., National Emergency 9400 series steels or SAE 4140, heat treated to meet specifications for alloy steel bolting material for high temperature service, American Society for Testing Materials A96, Class B physical properties minimum.

2. For temperatures over 850°F., Grade B14 steel per American Society for Testing Materials A193, heat treated to meet specifications for alloy steel bolting material for high temperature service, American Society for Testing Materials A96, Class C physical properties minimum.

(g) Bonnet bolt nuts shall be semi-finished carbon steel, normalized or quenched.

6. *General purpose steel valves: 600- & 1500-psi.—2 in. and smaller.* (a) End connections shall be:

1. Flanged American Standards Association standard with ¼-in. large male face

2. Screwed end
3. Socket welding end

The 600-psi. class flanged end valves may be made with 150-psi. American Standards Association steel flange diameter, drilling, and/or facing.

(b) Bodies and bonnets shall be carbon or carbon molybdenum steel, except when required to resist extreme corrosion or temperature conditions, in which case they may be 4 per cent to 6 per cent chrome, ½ per cent molybdenum, or stainless if so specified. (See definition for "stainless" in note under heading of Part 3.)

(c) Seating materials shall be any of the following:

Brass or bronze
Stainless (See definition in note under heading of Part 3)
Nickel copper alloy
Hard facing.

AWWA-NEWWA

Standard Specifications for Gate Valves for Ordinary Water Works Service

Sections in Specifications Which Are Modified by WPB Order L-252

AWWA NEWWA		WPB L-252—PART I
7.1	All bronze packing glands are eliminated but bronze nose piece may be used if two-piece gland is used. Iron packing glands may be brass bushed.	3(f)
8.4	Spot facing or back facing subject to limitation as recorded in 2(i).	2(i)
12.2	Bronze may be used *only* as allowed by L-252. Gates for solid wedge 4-in. and larger and for split wedge and double disc 5-in. and larger valves cannot be made all bronze.	3(b)
19.3	Use of solid bronze glands is prohibited.	3(b)
19.5	Gland bolts and nuts must be carbon steel.	3(d)
24.1	Bypass valves are subject to all limitations set up for main valve.	—
26.1	Bolts and nuts must be carbon steel. Rust-proofing is subject to whatever limitations control the use of cadmium, zinc. etc.	—

These statements have been cleared in conference with W. F. Lahl, WPB Administrator of L-252.

The above interpretation of WPB Limitation Order L-252 is recorded in accordance with authority conferred upon the undersigned by the Board of Directors of the A.W.W.A. Until further notice, valves furnished under A.W.W.A. specifications will be modified to the extent above indicated.

MALCOLM PIRNIE, *Chairman*
Committee on Water Works Practice
REEVES NEWSOM, *Vice-Chairman*
Committee on Water Works Practice
HARRY E. JORDAN, *Secretary*
A.W.W.A.

February 25, 1943

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Subchapter B—Division of Industry Operations

Part 1073—Fire Protective, Signal and Alarm Equipment

GENERAL LIMITATION ORDER L-39 AS AMENDED JANUARY 20, 1943

Editorial Note: *The limitations on fire hydrants, couplings, etc. are particularly applicable to the water works field. A.W.W.A. specifications are set aside to the extent indicated on p. 418.*

§ 1073.1 *General Limitations Order L-39*—(a) *Definitions.* For the purpose of this order:

(1) "Fire protective equipment" means: sprinkler systems, couplings, playpipes and allied fittings, fire hose, fire hydrants, fire pumps, hose dryers, hose racks, indicator posts, lightning rods, piped extinguishing systems, portable fire extinguishers including back pack types, foam generators, stirrup pumps, water spray nozzles, and all other fire protective equipment for preventing or extinguishing fires, excepting self-propelled motorized fire apparatus and auxiliary units including trailer, skid, front mounted and portable apparatus.

(2) "Signal or alarm equipment" means fire, police, and protective alarm and signal systems, including central station, proprietary, auxiliary and automatic fire alarms; watchmen's time recording, burglar, bank vault, hold-up and intrusion systems; and all other instruments and devices to detect, signal or warn against fire or other casualty, except air raid warning devices.

(3) "Dry-pendant sprinkler head" means a sprinkler head for use in a pendant position on a dry pipe system and permanently attached to an extension nipple so as to exclude water from the nipple.

(4) "Incendiary bomb control equipment" means any pump, device, instrument, or material designed for the removal, control or extinguishment of incendiary bombs.

(5) "Stirrup pump" means a manually operated pump used to draw water or other liquid from a separate container to extinguish or control fires.

(6) "Air raid warning device" means any siren, whistle, horn, diaphone, signal or device used or intended for use to warn or signal civilians in connection with air raids or other war hazards.

(7) "Copper base alloy" means any alloy in the composition of which the weight of copper equals or exceeds 40 per cent of the weight of all metal in the alloy.

(b) *General restrictions*—(1) *Restrictions on use of scarce materials.* Except as provided in paragraph (c) of this order, no person shall incor-

porate in any fire protective equipment, signal or alarm equipment, air raid warning device, or parts thereof, any aluminum, bismuth, cadmium, chromium, copper, lead, mercury, monel metal, nickel, tin, stainless steel, zinc, or alloy of any of said metals, asbestos, rubber, neoprene, or other synthetic rubber, except to the extent permitted in Appendix A hereof.

(2) *Restrictions on fire hose couplings.* Except as provided in paragraph (c) of this order, no brass fire hose couplings in the possession or control of any coupling manufacturer, fire hose manufacturer or distributor on April 27, 1942, shall be transferred, sold or incorporated in the manufacture or assembly of any fire hose.

(3) *Restrictions on foam extinguishers.**

(4) *Restrictions on manufacture of alkali metal (loaded stream) extinguishers.**

(5) *Restriction on manufacture of stirrup pumps.**

(6) *Restrictions on fire sprinkler systems.* (1) No person shall sell, purchase, deliver, install or accept delivery of any new or used fire sprinkler system or parts thereof, except pursuant to a preference rating of A-9 or higher.

(ii)*

(7) *Restrictions on signal or alarm equipment.**

(8) *Restrictions on air raid warning devices.**

(9) *Restrictions on cotton rubber lined fire hose.* (i) No person shall sell, purchase, deliver or accept delivery of any new or used cotton rubber lined fire hose, except pursuant to a preference rating of A-9 or higher.

(ii)*

(10) *Restrictions on manufacture of incendiary bomb control equipment.**

(c) *General exceptions.**

(d) *Representations on orders from government agencies.**

(e) *Records.**

(f) *Reports.**

(g) *Violations.**

(h) *Appeals.**

(i) *Applicability of priorities regulations.**

(j) *Correspondence.* Reports to be filed and other communications concerning this order shall be addressed to the War Production Board, Safety and Technical Equipment Division, Washington, D.C., Ref.: L-39.

(PD Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125; 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 20th day of January 1943.

(signed)
Ernest Kanzler
Director General for Operations

APPENDIX A

In accordance with the provisions of paragraph (b) (1) of this order, the materials named in this Appendix A may be incorporated in the manufacture of fire protective equipment, signal or alarm equipment, and air-raid warning devices, and in component parts thereof, to the extent indicated in this Appendix A:

(1) *Aluminum**

(2) *Bismuth**

(3) *Cadmium**

* Only the headings of certain sections are given here. Those interested in the omitted text portions, which are not of direct interest to the water works field, should obtain the complete document from their branch office of the WPB.

(4) *Chromium**

(5) *Copper or copper base alloys* (where copper base alloys are permitted, the alloys used shall be of the lowest type and grade that are practical for the particular application) in:

(i) Pumps for vaporizing liquid extinguishers;

(ii) Lock nuts on removable hose connections;

(iii) Bodies, ends, inner chambers, valves and their component parts for vaporizing liquids and loaded stream extinguishers;

(iv) Caps on 2½-gal. foam extinguishers;

(v) Fittings, strainers, siphon tubes and valves for carbon dioxide and gas operated dry powder extinguishers;

(vi) Snap clamps, clamp pins and wire springs for "Jones" type fire hose couplings;

(vii) Latch assembles for "British" type fire hose couplings to the extent essential to the efficient functioning of the parts;

(viii) Swivels and wires for screw type fire hose couplings;

(ix) Swivels, wires, and rollers for suction hose couplings;

(x) Couplings for portable water purification plants, and for ¾-in. and 1-in. chemical or booster hose;

(xi) Hose and hydrant adapters;

(xii) Swivels, wires, clappers and seats for siamese connections;

(xiii) Playpipes made only from drawn, brazed sheet or cast brass, not more than 2½ in. in diameter at the base, and not more than 15 in. long;

(xiv) Ball and cylinder type shut-off nozzles;

(xv) Nozzle tips for playpipes, and not exceeding 1½ in. diameter at discharge ends;

(xvi) Portable deluge nozzles, not including tips or handles;

(xvii) The following hydrant fittings to the extent essential to their efficient functioning: valve seats, discs, guides, operating valve stems, stuffing boxes; bushings, rivets, retainer rings, and outlet nipples;

(xviii) The following indicator post fittings to the extent essential to their efficient functioning; valve stems, seats, discs, packing glands and glands of bonnet openings;

(xix) The following parts of portable generators and fixed piped systems to the extent essential to their efficient functioning: generator bodies except bases; shut-off valves except handles; screens and check valves;

(xx) Water spray nozzles;

(xxi) Valve seats, discs, stems and guides;

(xxii) The following parts of automatic sprinkler systems and signal or alarm equipment: actuating, indicating and recording units of alarms or signal systems, condenser parts, contacts, diaphragm assemblies, labels of inspecting laboratories, closed sprinkler heads, links, tubing and fittings, valves not over 2 in., wire and cable, impellers and rings for fire pumps and for water flow alarms;

(xxiii) Impellers, retaining rings and bushings for fire pumps;

(xxiv) Watchmen's time recording systems where required for efficient functioning;

(xxv) The following parts of air raid warning devices: motors up to 3 hp., actuating units, wire and cable, control and reducer valves only to the extent necessary to the efficient functioning thereof.

(6) *Lead:*

(i) As a component of fusible link alloy or solder;

(ii) In underground pipe connections to the extent essential to efficient functioning of such connections, and in hose connections for hydrants;

(iii) In copper base alloys, the use of which is permitted by paragraph (5) hereof;

(iv) In alarm systems and as a coating on automatic sprinkler heads;

(v) As required for extinguisher nozzles, castings and valve assemblies for vaporizing liquid extinguishers, coatings of steel shells for foam or vaporizing liquid extinguishers, and coatings for couplings; and as a component of seat rings for dry pipe valves.

(7) *Mercury**

(8) *Nickel,* in signal or alarm systems as a component of bi-metal thermal discs for thermostats, as plating for protection against corrosion where magnetic properties of nickel are essential, as a component of wire wound resisters, as a component of thermocouple wire and as a component of permanent magnets.

(9) *Tin:*

(i) As a component of fusible link alloy; and in dry pipe valve seat rings, but not to exceed 50 per cent in weight;

(ii) In copper base alloys the use of which is permitted by paragraph (5) hereof, but only where no tin-free alloy can be used, and only to the extent essential to efficient functioning;

(iii) Up to 10 per cent by weight in metals used in the coating of copper or of copper alloys for anti-corrosion protection;

(iv) Up to 10 per cent by weight in metal for coating steel shells for foam and vaporizing liquid extinguishers;

(v) In solder up to 21 per cent by weight.

(10) *Stainless steel* (non-nickel bearing);

(i) In hinge pins used to dry pipe valves of automatic sprinkler systems, and in impeller shafts for fire pumps;

(ii) In nozzles and linings for automatic vaporizing liquid sprinkler units approved by Underwriters' Laboratories, Inc., or Factory Mutual Laboratories;

(iii) In the following parts of signal or alarm systems: cylinders, ratchet pins, and small shafts for signal or alarm mechanisms where the use of any less scarce material is impracticable, mercury check valves, ball bearings, latching parts, and pileup and adjusting screws where the use of any less scarce material is impracticable.

(11) *Monel metal,* in balls for ball-type check valves for dry pipe valves of automatic sprinkler systems.

(12) *Zinc:*

(i) In essential parts of alarm and signal systems when a less critical material as a substitute would not be suitable;

(ii) In copper alloys, the use of which is permitted by paragraph (5) hereof;

(iii) In die cast parts;

(iv) As protection against corrosion of iron or steel parts in extinguishers, pump tanks, fire hose couplings, and expansion rings;

(v) As sheet to the extent that corrosion-resistant metal is essential to efficient functioning and galvanized steel sheet is not suitable.

(13) *Asbestos:*

(i) In gaskets for hydrants, fixed foam applicator pipes and alarm systems;

(ii) As packing for vaporizing liquid extinguishers.

(14) *Crude or reclaimed rubber* for diaphragms, gaskets, and lining for cotton rubber lined hose; and reclaimed rubber for hose for fire extinguishers.

(15) *Synthetic rubber* other than neoprene, to the extent essential to efficient functioning.

AWWA–NEWWA

Standard Specifications for Fire Hydrants for Ordinary Water Works Service

Sections of Specifications Which Are Modified by WPB Order L-39

Sec. 4.05

(Parts of non-corrodible metal) and

Sec. 4.06

(Characteristics of non-corrodible metal) In the AWWA–NEWWA specifications use affected by L-39 Appendix A, Sec. (5) and (xvii) thereof which reads as follows:

> The materials named may be incorporated in fire protective equipment to the extent indicated:
>
> Copper—(xvii) The following hydrant fittings to the extent essential to their efficient functioning: valve seats, discs, guides, operating valve stems, stuffing boxes, bushings, rivets, retainer rings, and outlet nipples;
>
> (xxi) Valve seats, discs, stems and guides;

Sec. 4.07

(Facing of main valve against seat) If rubber valve facing is ordered, crude or reclaimed rubber may be used (L-39, Appendix A, (14)) provided that such material is available at rating furnished.

Sec. 4.08

(Bolts and nuts) Cadmium and/or zinc cannot be used as corrosion resisting materials (L-39, Appendix A, (3) and (12)).

It should be noted that L-39 does not forbid the use of copper bearing alloys at points in hydrants where their omission would seriously affect the service rendered by the unit.

The above interpretation of WPB Limitation Order L-39 is recorded in accordance with authority conferred upon the undersigned by the Board of Directors of the A.W.W.A. Until further notice, hydrants furnished under A.W.W.A. specifications will be modified to the extent above indicated.

MALCOLM PIRNIE, *Chairman*
Committee on Water Works Practice
REEVES NEWSOM, *Vice-Chairman*
Committee on Water Works Practice
HARRY E. JORDAN, *Secretary*
A.W.W.A.

February 20, 1943

War Production Board

Administrative Letter to All Utilities (PDL–1721)

ORDERS FOR CRITICAL COMPONENTS

On January 28, 1943, a letter was sent by the Director General for Operations to all holders of project rating orders. Its purpose was to stimulate advance ordering of Critical Common Components in order to permit a calculation of total requirements and an improvement of scheduling techniques. The text of the letter was as follows:

"Attached is a list of Critical Common Components. It is essential that all orders for these items, or for end items into which these components enter, requiring delivery prior to June 30, 1943, be placed prior to February 6, 1943, and orders for all items required between July 1, 1943, and December 31, 1943, be placed prior to March 1, 1943, in order to assure consideration in the scheduling of the components. If you have not already placed orders for all such equipment required in your construction projects, please do so at once."

We are enclosing with this Administrative Letter the list which was attached to the letter of January 28. *In accordance with this letter, orders should be placed with your suppliers for components appearing on the list which you will require for construction which has been previously authorized by the War Production Board. Orders should not be placed for equipment for use in construction which has not yet received definite approval from the War Production Board, even though you estimate that you will need such equipment prior to December 31, 1943. Orders for critical components required for maintenance and repair during 1943 should also be placed as soon as possible, but should be limited to your definitely foreseeable needs.*

Orders that are placed promptly, even though later than the deadline, will receive every consideration, and to the extent possible will be fitted into manufacturing schedules on the basis of their relative war urgency.

Very truly yours,
(signed)
J. A. Krug
Director
Office of War Utilities

Enclosure [see next page]

Critical Common Components

As approved by the Sub-Committee on Production Scheduling and by the Office of the Director General for War Production Scheduling, W.P.B., Ralph J. Cordiner.

Amplidynes and Selsyns
Bearings, Ball and Roller
Bearings, Jewel
Vee Jewel Bearings
Large Ring Jewel Bearings
Boilers
Boilers, Central Steam Heating and Steam Power Generating
Boilers, Hot Water Heating and Steam Heating
Blowers and Fans
Blowers and Fans, including turbo blowers
Capacitors, Power and Fixed Type
Capacitors, Variable
Capacitors, Fixed
Compressors and Vacuum Pumps
Conveying Equipment
Control Instruments
Control Instruments, Electrical Control —Combat
Control Instruments, General Industrial Controls
Crankshafts
Extinguishers, Carbon Dioxide
CO_2, used as extinguishing agent
Cartridge type CO_2, used as expellant
Electric Motors, Generators and Starters
Forgings (Aluminum)
Piston Upsettings
Press Forgings
Small Hammer Forgings
Large Hammer Forgings, including Propellers and Engine Parts
Press and Hammer Forgings for Aircraft 8-L Program
Gears
Gears, Aircraft Engine
Main Reduction Gears (ships)
Hydraulic Parts
Hydraulic Parts—hydro-generators above 6000 kw. capacity—(actuating cylinders)
Hydraulic Parts
Heat Exchangers
Hand Tools
Heavy Forged Tools
Wood-Working Tools
Hand Service Tools
Machinists Vises
Metal Cutting Tools
Precision Measuring Tools
Gasoline Engines (Other Than Aircraft)
Gasoline Engines—0–35 hp. (air cooled)
Gasoline Engines—water cooled—0–50 hp.
Gasoline Engines—water cooled—50–150 hp.
Gasoline Engines—heavy duty—150 hp. and over
Gasoline Engines—high speed—over 150 hp.
Gasoline Engines—50 hp. and above
Engine Accessories
Carburetors for Engines of 1,000 hp.
Magnetos
Fuel Injection Equipment—one-cylinder pumps
Fuel Injection Equipment—multi-cylinder pumps
Fuel Injection Equipment—nozzles and holders
Lenses
Lenses, optical
Meters
Steam Engines
Steam Engines, shipbuilding
Pumps, Industrial
Turbo Blowers and Exhausters
Vacuum Tubes
Auxiliary Turbines
Auxiliary Land Turbines (generators)
Auxiliary Land Turbines (mechanical drive)
Valves and Fittings
Bronze Valves
Iron Valves
Steel Valves
Steel Fittings
Machine Tools and Industrial Equipment
Machine Tools
Diesel Engines
Diesel Engines—0–50 hp.
Diesel Engines—50–150 hp.
Diesel Engines—150–350 hp.
Diesel Engines—over 350 hp.
Diesel Engines—all sizes
Main Propulsion Turbines
Welding Rods and Electrodes
Parker Type Fittings
Parker Type Fittings
Parker Type Fittings—includes Weatherhead type
Parker Type Fittings—Parker and Weatherhead type hydraulic valves